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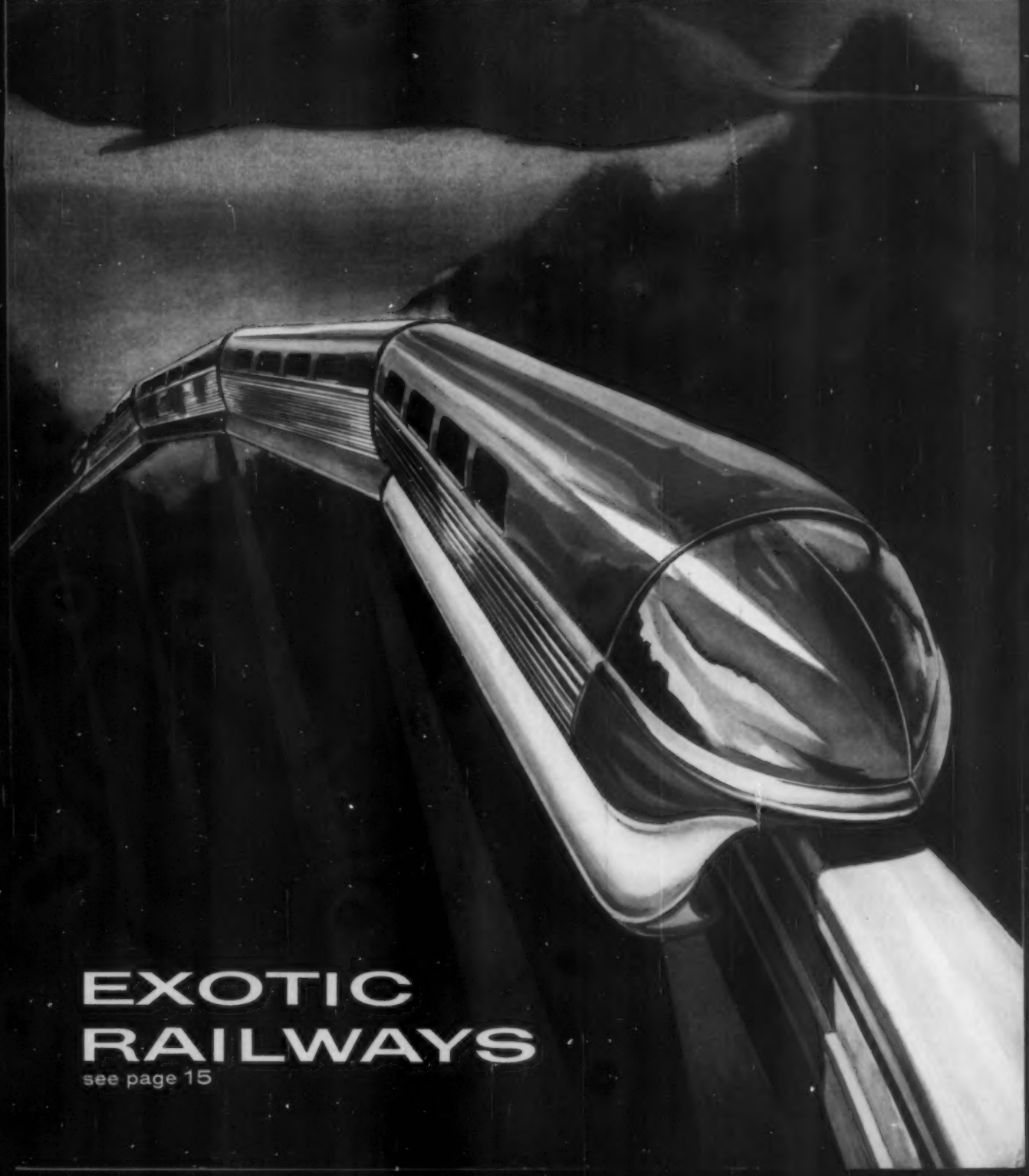
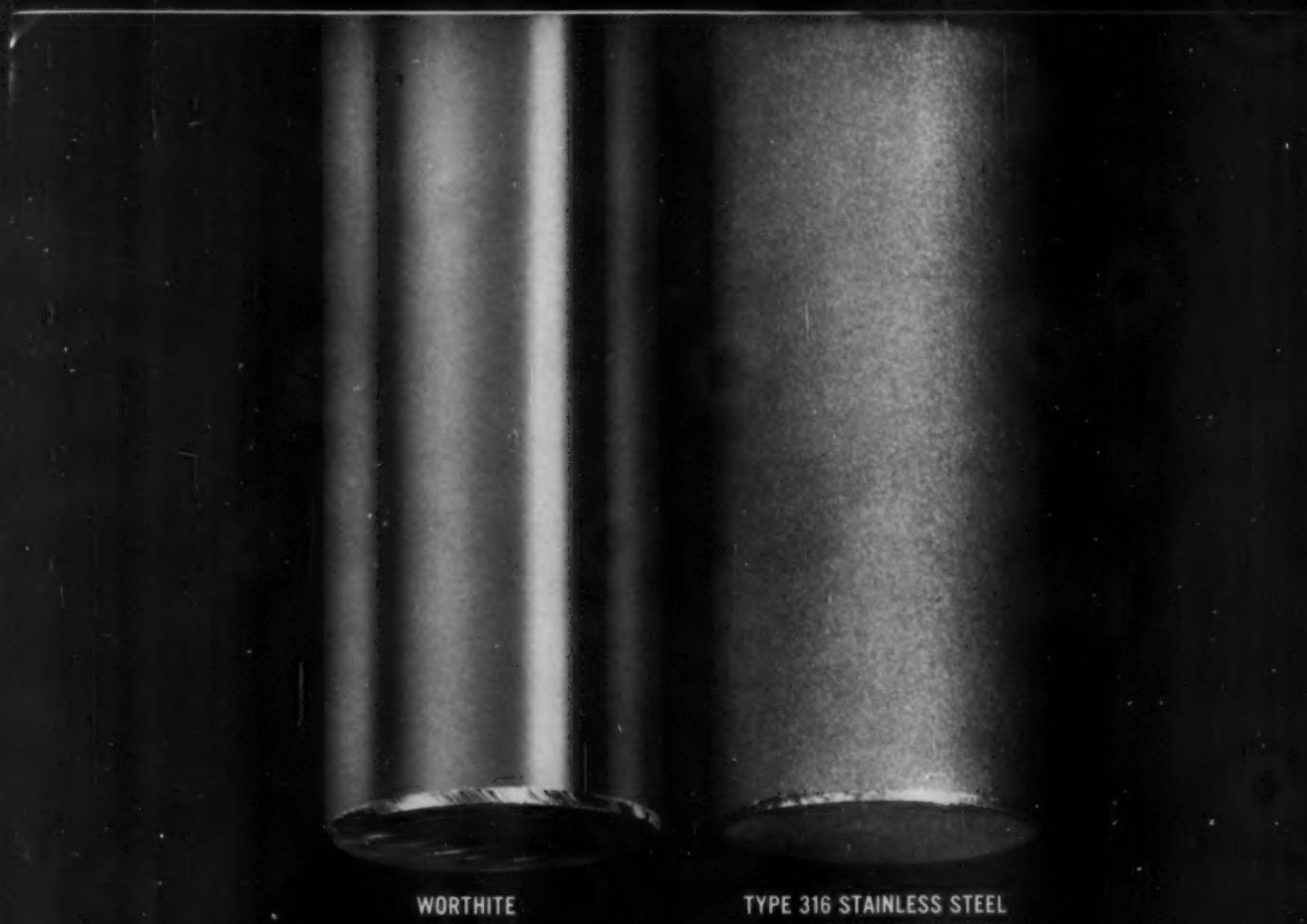
PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT · JANUARY 25, 1960



EXOTIC RAILWAYS

see page 15



Here's proof of Worthite's superior corrosion resistance. Both bars were immersed for 56 hours in 40% sulfuric acid solution at 125° F.

ARE YOU WILLING TO SPEND A FEW PENNIES MORE FOR THIS KIND OF PUMP PROTECTION?

Worthite* has become the standard pump material for corrosive applications for one simple reason: it gives a whale of a lot more protection for a premium of just a few percent.

By standardizing on Worthite, a user gets flexibility to make changes in processes without running up against more corrosive liquids than his pumps can handle.

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Chromium	20%	18%
Nickel	24%	14%
Molybdenum	3%	3½%
Silicon	3¼%	1%

Worthite has almost twice as much alloying material, yet it costs but a few pennies more.

What's the reason for Worthite's low price? By standardizing on this one alloy and by quantity buying and production, Worthington has made its price competitive with ordinary stainless steel.

Worthington manufactures standard centrifugal pumps in Worthite in ⅜ to 8 inch sizes. There's a size to meet all your requirements. If you'd like to learn more about Worthite, we'd be happy to send you a 28-page technical bulletin which gives physical properties plus a list of corrosive solutions which Worthite has successfully handled. Write Worthington Corporation, Section 20-12, Harrison, New Jersey. Ask for Bulletin 2000-B2.

WORTHINGTON

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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

January 25, 1960 Vol. 31, No. 4

FEATURED:

DEPARTMENTS:

INTERESTING TO NOTE 3
COMING NEXT WEEK 4
DEVELOPMENTS TO WATCH 7
WHAT'S NEW IN RESEARCH 9
FROM WASHINGTON 13
THE ENGINEERING WEEK 15
APPEARANCE DESIGN 24
READER TO EDITOR 28
COMING EVENTS 28
WHY NOT R&D? 32
HORIZONS 45
PRODUCT DESIGNS 54
SIGNIFICANT COMPONENTS 73
DESIGN LITERATURE 88
CURRENT REPRINTS 102
ADVERTISERS' INDEX 108
READER SERVICE CARDS 111

MORE ENGINEERING PER ENGINEER . . . E O Klimt, McDonnell Aircraft Corp
The way to measure and improve engineering effectiveness..... 47

HOW TO MEASURE CYCLIC SPEED VARIATIONS . . . R R Anderson, Bell Labs
Of 6 methods, the new slit-type optical tachometer works best..... 50

DAMPING TAPES FOR VIBRATION CONTROL . . . E E Ungar
Author shows cheap, reliable way; with equations, sample problem.... 57

7 STEPS TO BETTER ORAL REPORTING . . . E J Tangerman, editor
Third in the series: preparation of notes for your talk 63

NEW WAY TO MEASURE DUTY CYCLE . . . R E Seely, General Electric Co
It gives motor-winding resistance under load conditions..... 64

SHORT-RUN BLANKING: RUBBER DIE PROCESS . . . E J Hills, RCA
Economical way to turn thin sheetmetal into complex shapes..... 66

7 WAYS TO LIMIT SHAFT ROTATION . . . I M Abeles, General Electric Co
Ingenious mechanisms use traveling nuts, clutch plates, etc..... 70

FIELDS OF INTEREST REPRESENTED IN DEPARTMENTS:

MATERIALS: **Silicon nitride shows promise** for hi-temp service..... 8
Better cast iron promised by minor alloying additions..... 9

MECHANICAL: **Valves actuated by bimetal disks** give wide control range..... 73
Silent valve eliminates problems caused by rapid flow..... 73

ELECTRICAL: **Thermionic conversion** considered source of atomic power..... 9
Guillotine-type socket aids removal, replacement of tubes..... 73

PRODUCT DESIGN: **Simplified actuator** for hydraulic or pneumatic service..... 8
Coded carts speed the mail—the new Post Office method..... 54

PROCESSES: **These adhesives cure themselves** by supplying their own heat..... 7
Route to stronger steels—heat treatment plus deformation..... 9

GENERAL: **Those first 30,000 miles**—biggest radiation danger to spacemen..... 7
No major changes in NASA are likely in 1960..... 13
Monorails stage a comeback; why the idea is being revived..... 15
Misdirected R & D threatens new weapons..... 21

New steels are born at Armco

Tank head (top), bracket (bottom), and control valves (center) illustrate the great workability of Armco ZINCGRIP.

Brady cuts costs, simplifies design, speeds assembly, improves performance with Armco ZINCGRIP Steel

Rust resistance of Armco ZINCGRIP® Steel helps water pressure tanks and controls manufactured by Brady Air Controls, Inc., Muncie, Indiana, provide the trouble-free service home owners want. Workability of this special hot-dipped, zinc-coated steel also means cost-cutting production advantages, especially in fabrication of air volume control valves.

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Originally, valves were two cup-shaped die-castings, joined by bolts, with a diaphragm between them. Now halves are formed from ZINCGRIP Steel and the diaphragm inserted. Both parts are then securely locked together by a reverse draw that creates an airtight seal. Rust is sealed out, too, because ZINCGRIP's tight coating does not flake or peel despite this severe fabrication.

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You, too, can cut costs and increase your product's sales power with Armco ZINCGRIP. Its zinc coating stays intact through severe working for many corrosion-resisting applications where more costly or hard-to-fabricate materials are now used. Mail the coupon today for more information.

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INTERESTING TO NOTE

Monorails Are Back Again

Monorails have often been suggested as an answer to the commuter problems that plague some of our larger cities. Although monorails are not now being used as an aid to rapid transit in the US, they have been attempted. (One was tried in Houston; there is an Alweg monorail at Disneyland and Seattle is now considering a monorail system for its upcoming fair).

The concept of a single-track railroad was first proposed in 1896 by Louis Brennan. In 1882 Irishman Brennan invented a torpedo that was guided by wires from the shore. Since his torpedo was stabilized by gyros, he believed a monorail car could also be gyro-balanced. In 1910 he displayed a successful working model which traveled around a circular track at 20 mph. The same year, a German, August Scherl, demonstrated a similar monorail in Brooklyn. Nobody was interested in financing either system and the ideas of both Scherl and Brennan went for naught.

At about the same time, a mountain railway near Salzburg added a new dimension to the monorail idea. A railroad car was placed on a single track going up a mountain. A huge balloon was attached to the car, literally floating the car and its 10 passengers up the mountain. To get back down, water was poured into a large tank within the car. The added weight was enough to take the car back down again.

Recently, discussions of monorail systems have been revived. The news story on page 15 discusses and evaluates these current arguments.

Don't Say That Word

For the past two weeks the PRODUCT ENGINEERING series on oral reporting has been providing valuable pointers for present and future podium-pounders. The third article in this series can be found on page 63. One interesting aspect of public speaking, or even daily discourse, is the fear we have of mentioning certain "never spoken" words. For example, we prefer saying "passed on" to "died," and "let out" to "was fired." The "disposal truck" has replaced the "garbage wagon" of old. "Janitors" are now "custodians" and the "young criminal" is now a "juvenile delinquent."

"Woman" as a word gave our so-proper ancestors a great deal of concern. They decided that the word was too suggestive and referred to that hard-to-name half of the population as "females." Vassar College, one of the country's oldest women's colleges, was opened in 1865 as "Vassar Female College." Our habit of asking for white or dark meat when ordering chicken or turkey dates back to the 1840s when nobody with breeding said "breast" or "leg." To save dinner guests from starvation

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January 25, 1960 Vol. 31, No. 4

PRODUCT ENGINEERING is published weekly — with an additional Design Digest issue in Mid-September, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), founder. PUBLICATION OFFICE, 99-129 North Broadway, Albany 1, NY. See Index to Advertisers for directions regarding subscription or change in address.

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W 42nd St, New York 36, NY. United States subscription rates for individuals in the field of the publication, $5 per year, single copies 50 cents; Canadian subscriptions $7 per year; foreign $25 per year, payable in advance. Second-class postage paid at Albany, NY, USA. © Copyright 1960 by McGraw-Hill Publishing Company, Inc. All rights reserved.

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POSTMASTER: Please send form 3579 to PRODUCT ENGINEERING, 330 W 42nd St, New York 36, NY.

or embarrassment, some kind hostess invented the still-used substitutes.

Word taboos are certainly not exclusively American. To mention a predatory or a sacred animal's name, in many parts of the world, is to call his wrath upon you. Thus the Algerian Arabs mention the lion only as "Mr. John Johnson" and the Bechuana tribe of South Africa refer to him as "the boy with the beard." Because of the widespread superstition that the strength of a man or god resides in his name, many primitives literally travel incognito through life, using substitute names to prevent enemies from gaining power over them. For this reason, it was once high treason in Thailand, Burma, China and Korea to call the king or emperor by his name. Complimentary titles had to be used instead. Even today we still address our Chief Executive as "Mr President."

First Mailmen—Juvenile Delinquents

When the Olympic speedster Philonides of ancient Greece carried a message 60 miles in nine hours, it marked the first time mail was carried crosscountry. Since then a wide assortment of conveyances have been used to carry the mail (see page 54). The first system of mail handling was set up by early kings to convey their own personal messages. Attempts at private letter writing were looked upon suspiciously, and postal routes were carefully watched by agents of the ruling power..

By 1653, the first popular mail was attempted. Count de Villayer obtained royal consent, set up 11 mail boxes and promised 3 collections and deliveries daily in Paris. But vandals spoiled his effort; they leaped into mail carriages to intercept messages, and later filled mail boxes with litter. Less than 30 years later, England copied the de Villayer plan; and 400 receiving offices were spread over London. There were 4 to 12 collections daily. Cost was only one penny and letters were insured up to 12 pounds sterling at no extra charge. Again vandals threatened, but English officials had the answer—fight fire with fire. Young hoodlums were given jobs moving the mail. They became the world's first postmen in the modern sense.

—Benedict A Leerburger Jr

SIDELIGHTS

Engineering effectiveness (p 47) is getting real attention at a certain Midwest aircraft plant, we hear. Some management genius invented the "think tank"—an 8 x 11-ft prison with desk, lamp and, presumably, uninterrupted quiet, where engineers can "search and study the physical sciences with their theme geared for applied technology. These men are not tied to product problems eight hours a day," we're told. "Because of this the group can initiate research into any area, constantly seeking out the bridges which will allow them to cross existing plateaus of scientific knowledge so that products of tomorrow can be built." If they think they need bridges to cross plateaus they may be researching themselves right out of business.

We've an in-built distaste for the put-them-in-a-tank-and-make-them-think philosophy. Also we are not very sympathetic to the practice of setting up a privileged group with express orders to read the scientific journals for ideas, implying that the rest of the staff can jolly well grind out the eight-hours-a-day product problems.

NEXT WEEK IN PRODUCT ENGINEERING

. . . **Dimensional Analysis in 10 Steps**
To derive an empirical equation relating a large number of variables, start with dimensional analysis.

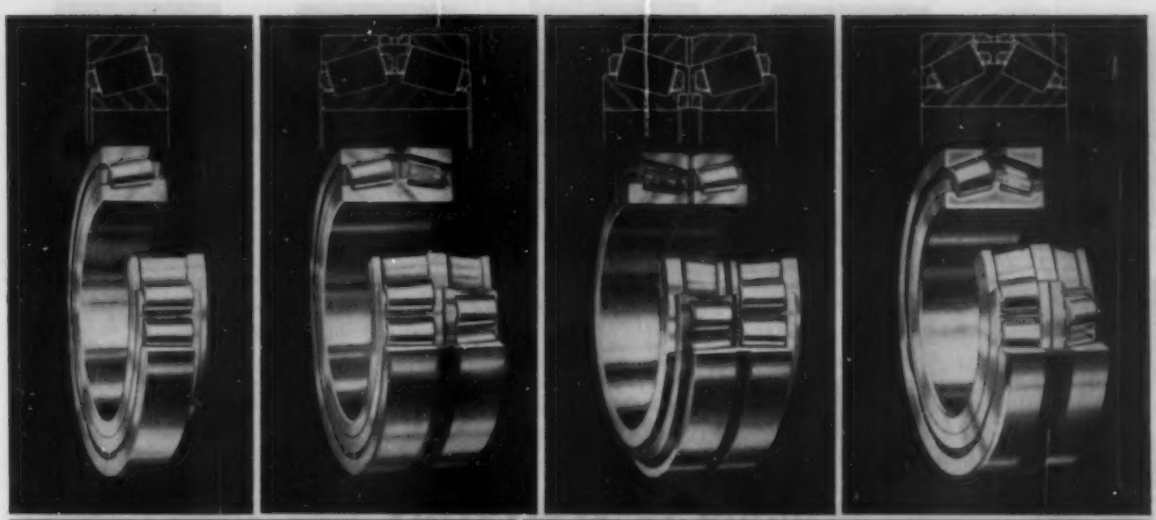
. . . **Shaft Twist**
An easy way to find the dimensions of a hollow circular, elliptical, square or rectangular shaft with the same torsional deflection as a given solid circular shaft.

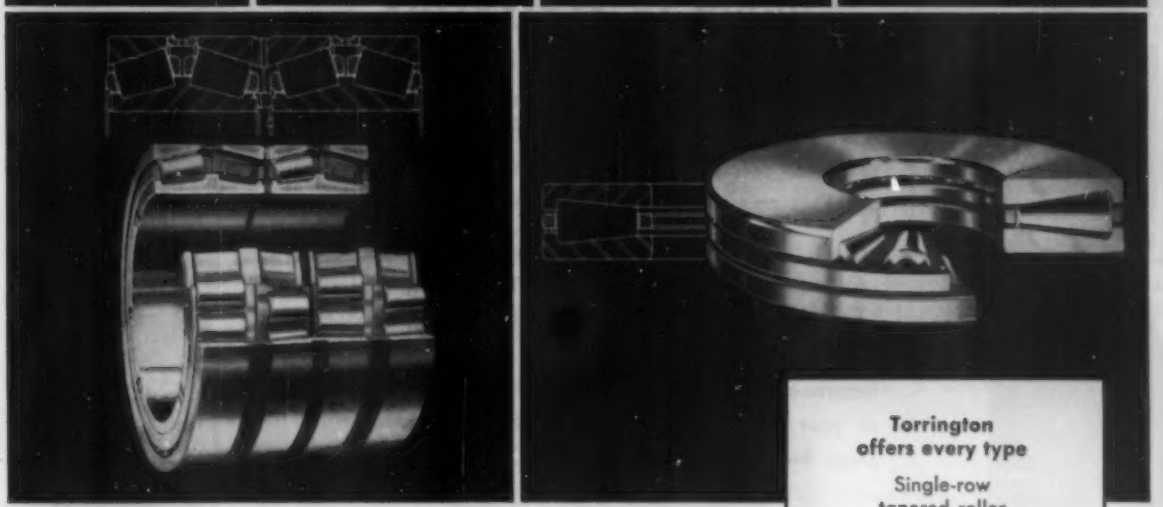
. . . **How to Estimate Cost of Hi-temp Alloy Parts**
A rule-of-thumb guide when deciding complexity of part and method of manufacture.

. . . **For Tiny Parts—Minicast Does It Cheaper**
Here's a method, using plastic patterns, that is suited to 1-in.-dimension parts made in quantities of over 25,000.

. . . **Springs That Kill Shock**
Even without the dimensions these equations quickly find the lightest spring needed to aborb impact of a mass.

. . . **Infrared for Heating a Product**
Practical guide helps designers choose among the various methods.





Torrington offers every type

Single-row tapered roller

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Two-row tapered roller, solid cone

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Two-row tapered roller, solid cup

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Steep angle, two-row tapered roller

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Four-row tapered roller

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Conical roller thrust

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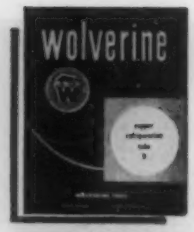
2. Wolverine Aluminum Catalog

3. Opportunities Unlimited

4. Wolverine Trufin Catalog



5. Copper Refrigeration Tube Book

6. Measure of Tubemanship

When it comes to tube... come to Wolverine

From Wolverine Tube, manufacturers can obtain a great variety of tubular products. These range from such products as tiny, plug-drawn Wolverine Capilator® used for restriction purposes, to commercial copper tube up to 6 inch O.D. and aluminum tube to 3 inch O.D.

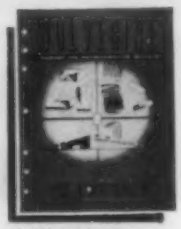
Illustrated on this page—and reading like tubing's "best seller" list—is the latest Wolverine Tube literature dealing with all the company's products and specialized services. Look these catalogs over. A request, on your letterhead, will bring you the catalog . . . or catalogs . . . of your choice without delay or obligation. Just write Dept. S—TODAY!

10. Water Heater Catalog

7. Design & Cost Comparison

11. Commercial Tubing Book

8. Process Flowsheets



12. Wolverine Serves The Refrigeration Industry

9. Statement of Scope

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URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION
In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO. LTD.
UNIFIN TUBE DIVISION

WOLVERINE TUBE
DIVISION OF
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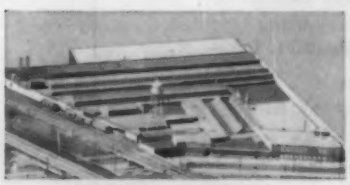
PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA.
SALES OFFICES IN PRINCIPAL CITIES.

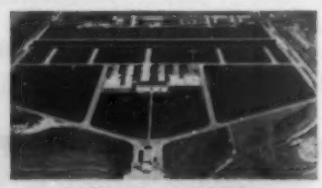
13. Copper Water Tube Catalog

PLANTS LOCATED:

14. Wolverine Corrosion Chart



DETROIT, MICHIGAN



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DEVELOPMENTS TO WATCH . . .

Adhesives that cure themselves . . .

. . . by supplying their own heat via chemical reaction are under test at Narmco Industries Inc. Using mixtures of metal with metal oxide and metal with glass, R. A. Long of Narmco has developed two bonding processes for stainless steel and other metals. He believes both methods show industrial promise.

In one ("exo-brazing"), heat supplied by chemical reaction raises the temperature of the materials to be bonded to a point where the brazing alloy melts and forms the bond. The heat source in this case might be a powder mixture of boron and V_2O_5 or boron and CuO.

In the other ("exo-adhesive") process, the chemical reaction supplies the heat, and also produces the bonding material. For this purpose, both oxide-metal systems and metal-glass systems have been tested. The reactive mixture may be applied as a paint (by suspending the powder in an alcohol vehicle); or it may be inserted into the joint in the form of a die-pressed wafer. The assembly is first heated to the ignition temperature of the mixture. Then the chemical reaction takes over, supplying the additional heat needed to wet the metal surfaces and produce the bonding material. Such combinations as Al-Cu_2O-SnO_2, Mg-NiO-MnO_2, and Borax-SiO_2-B-CuO may be used, resulting in such adhesive products as CuSn-Al_2O_3, NiMn-MgO, and Cu-glass.

Of the two exo-adhesive systems, the glass-forming method has given best results thus far, but research on both, as well as on exo-brazing, is continuing.

The first 30,000 miles will be the hardest for the space traveler . . .

. . . That, at least, seems to be the extent of the greatest radiation danger.

Originally, it was thought that there were two radiation bands around the earth, 600 and 2400 miles out. Scientists now believe the bands merge, creating a continuous danger belt.

The latest space probes indicate that the radiation level rises from 100 counts per sec just above the earth's surface to about 6000 at 1600 mi. The count drops slightly at that point, then resumes its rise to 50,000 to 300,000 counts per sec (the figure does not seem to be constant) at about 20,000 mi. Beyond that, it drops off rapidly—to 100 counts per sec at 30,000 miles and even lower at greater distances.

Space travelers won't be completely out of danger at 30,000 mi, however. Evidence indicates that there are similar bands, magnetically trapped around other celestial bodies, so space travelers may have trouble as they approach their destination. Testing this hypothesis will be one of the major objectives of our first planetary probe.

Mechanical treatments can promote useful chemical reactions . . .

. . . in rubber and other polymers, says Dr W. F. Watson of the British Rubber Mfrs Research Assn.

It's long been known that milling and other mechanical treatments can break down rubber macromolecules. But Watson believes processes like this can have much wider application.

USSR researchers have shown, he says, that nitrile rubber masticated with phenol-aldehyde resins, epoxies, and coal tar can produce new compounds offering controlled elasticity and other desirable properties.

The trick seems to be to carry out the mastication in a vacuum or inert atmosphere. That way, the molecular fragments are not inactivated by oxidation as they are created, so further reactions are possible.

Transistors score another point in size-reduction and portability . . .

. . . as Pyror SA of Switzerland introduces its newest colorimeter. A 6-transistor amplifier, plus compact design of the lens and light system, make it possible. In the new unit (see photo), output of the silicon photo cell is fed to the amplifier and then to a moving-coil indicator which is calibrated directly in percent of light transmission.

Miniature colorimeter is only about 3 by 5 by 1 in.; can be used with either colored glass or interference filters.

DEVELOPMENTS TO WATCH...

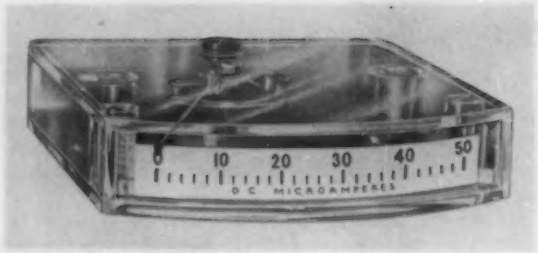
(continued)

Miniature edgewise panel meters . . .

. . . developed in England will soon be marketed in the US. These are tiny (2½ by ¾ by ⅝ in.) center-pole moving-coil units, mechanically shielded, with an accuracy of 2%. Weight is approximately 5 oz.

According to the manufacturer, Taylor Electrical Instruments Ltd, Slough, England, the units can be supplied as voltmeters, milliammeters and microameters, and can be used as sound-level meters for tape recorders, transmitters, amplifiers, output indicators, and null indicators.

At present, they may be obtained directly from England at prices ranging from $7 to $21.



Space-saving meter is just about this size.

Flexible corner for honeycombs and other sandwich panels . . .

. . . that's strong, light in weight, and eliminates sealing problems is under development at Monogram Precision Industries, Culver City, Calif. It's an extruded aluminum section that acts as a shock absorber as well as a seal, can be applied to standard paneling. Design information will be in a forthcoming issue.

Silicon nitride as a structural material . . .

. . . for high-temperature service is receiving new attention both here and abroad.

In Britain, the Admiralty Materials Laboratory is working on a combination of silicon nitride and silicon carbide which, it says, has thermal shock properties at 930 F, "equal to those of some metals." Developed for mechanical parts of gas-turbine stators and as an electrical insulator for rocket parts, the material is said to have excellent creep and oxidation resistance and good electrical properties. Its coefficient of thermal expansion is said to be 2.5 x 10^{-6}/°C at 4000 psi (tensile); and its transverse rupture strength, 13 psi at 2200 F. These values, however, decrease slightly as the percentage of SiC is increased.

Test specimens containing about 5% SiC withstood 50 cycles of rapid heating to 1830 F before peripheral cracks appeared.

In addition to the applications noted above, the British also expect the new material to be superior for thermocouple sheaths and crucibles, for which Si_3N_4 is already widely used, and for furnace structural parts.

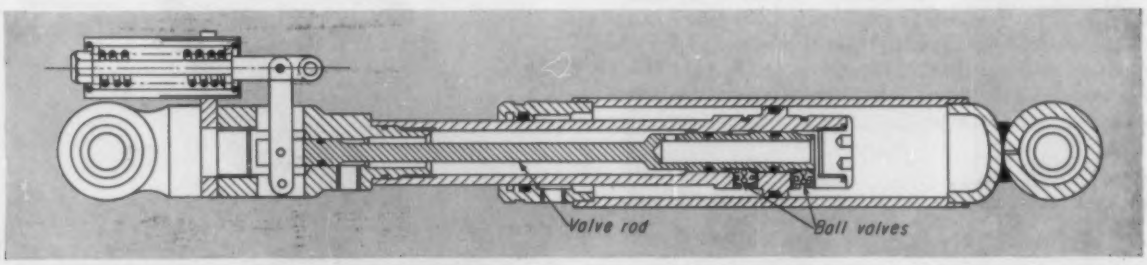
A simplified actuator for hydraulic or pneumatic service . . .

. . . has been designed in England. It's a piston-type unit that requires only one pressure pipe and one exhaust pipe, and can be operated either as a conventional cylindrical valve or as a servocontrol cylinder.

In the servo type the cable or hydrostatic input signal determines speed and displacement. Provision is made for positive locking of the input valve; and the piston can be extended to "any reasonable limit." "Leak-proof" ball valve design is said to reduce hydraulic fluid requirements and permit use of a smaller pump or electric motor.

The non-servo type, solenoid-operated (see diagram), is designed to maintain a constant speed in either direction for a given load.

British price for pneumatic servos in the smaller sizes (2-in. bore, 400-psi max working pressure) is on the order of $84; for the small hydraulic units (1½-in. bore, 3000-psi max working pressure), about twice that much. As yet, there is no US distributor, but information may be obtained from Hydraulics & Pneumatics Ltd, Wolverhampton, England. —ARG



Ball valves in new actuator are connected to central valve rod; control movement of fluid within actuator. When valve rod moves outward, ball valve at right opens, allowing pressure in chamber at left to rise until it balances the external load. When the valve rod is moved inwards, ball valve at right opens, allowing pressure to fall again.

WHAT'S HAPPENING IN RESEARCH...

Heading for better cast iron parts

Minor alloying additions can make a big difference in performance of cast iron parts, recent British reports show.

Phosphorus, for example, in quantities to 0.8%, increases both strength and hardness of grey cast iron. To see whether this element also can be used to raise the proof stress of commercial black heart malleable, British Cast Iron Research Assn now has a research program underway. Major aim: to find ways to take advantage of the element's good effects without causing serious embrittlement.

Aluminum, too, is under study at BCIRA. Here, the problem is that small additions of this element are helpful in promoting nodularization; but, at the same time, it tends to increase hydrogen pickup from the mold —with a consequent increase in porosity. BCIRA is attacking this problem from two directions:

First, trying to find a way to retain aluminum's advantages while neutralizing its disadvantages.

Second, searching for alternative elements which will ensure efficient inoculation without causing pinholing. BCIRA says at least one such element has been found and is now under test. While BCIRA does not say what this element is, an independent report from another laboratory suggests one possibility: tin.

Until recently, tin in cast iron had a bad reputation. It was believed to cause brittleness and to have an adverse effect on structure. But, says the Tin Research Institute, in quantities at least to 0.1%, this is not the case. Tin is "an active and potent promoter of pearlite," and may well be a means for increasing impact strength and wear-resistance. Addition of small quantities of tin to cast iron can provide a simple technique for producing "structures of the type known by experience to possess maximum wear-resistance coupled with good machinability." Possible applications: piston rings, cylinders, crank shafts, and rolls.

TRI also notes that tin may be helpful in improving such mechanical properties as tensile strength and hardness. But, its metallurgists caution, "we should not at this stage propose use of tin for this purpose. Other additives that act as strengtheners or hardners may meet particular requirements at lower cost."

Another route to atom power?

Can thermionic conversion be used to produce electricity from nuclear heat? A good many researchers are trying to find out; among them, a group at GM research labs. They've been running a series of experiments with the U of Mich reactor in which nuclear heat maintains the cathode temperature in a thermionic diode, and nuclear radiation helps to promote current flow.

In this device, known as a **noble gas plasma diode**, highly enriched uranium carbide is the cathode, aluminum is the anode, and the intervening space is filled with argon. By using enriched uranium carbide for the cathode, the GM researchers get a combined electron and ionization source, reducing the space charge in the area between anode and cathode as the current flows.

It is too early to say, the GM researchers admitted at last week's SAE meeting, whether the system will be efficient enough to be practical. But they believe they have demonstrated conclusively that "space charge neutralization by a fission-fragment-generated plasma allows a thermionic diode to be operated as an energy converter."

Along the road to stronger steels

Recent announcements of developmental steels with tensile strengths to 500,000 psi have emphasized two routes: alloying and cold working. Now, a report from Defense Metals Information Center serves as a reminder of a third: **heat treatment plus deformation** by rolling or stretching prior to final quenching.

Several such combination systems have already been described; among them, Ford Motor Company's Ausforming process and a similar system developed at Watertown Arsenal.

Examination of the record, says DMIC, indicates that steels with 0.30 to 0.40% carbon, to which conventional heat treatment imparts good properties, can be improved by deforming the metastable austenite; and for a given steel, there appears to be an optimum deformation for improvement in yield and tensile strength.

As a result of the survey, DMIC suggests a broad-scale research program, including:

- Investigation of behavior of standard sheet steels now used in aircraft and missile construction, including such compositions as MX-2, MBMC-1, and Tricent.
- Comparison of vacuum-degassed steels with air-melted steels.
- Development of techniques to maintain properties in the weld zone and heat-affected zone of Ausformed high-strength steel.
- Evaluation of hot-cold worked steels for notch sensitivity, hydrogen embrittlement, and reliability of minimum properties.

A copy of the report, with tempering charts, may be obtained from DMIC, Columbus 1, Ohio.

brief . . .

Fatigue cracks that don't travel are under study by NASA researchers. The aim: to find out why, under some conditions cracks will develop, but will not spread. These nonpropagating fatigue cracks have been observed in both steel and aluminum, though the appearance and behavior of the cracks is different in the two materials.

Nonpropagating fatigue cracks were formed under long-continued constant-amplitude cyclic loading at low stress in all cases where the size-corrected theoretical stress concentration at 0.001-in. notch was below the fatigue limit; whereas such cracks formed only where the stress concentration was above the fatigue limit when the notch radius was 0.005 in. But in steel, the cracks were self-closing under compression; in aluminum they were not. —ARG

Got a problem that calls for thread-cutting screws?

PARKER-KALON offers three new, improved thread-cutting screws for every application in every material

1 New, Improved P-K Type F*

. . . hardened thread-cutting screws developed for use in friable, granular or brittle material. The pilot, with its five tapping flutes, cuts a machine screw thread as the screw is turned in. The Type F is ideal for making fastenings to ferrous and non-ferrous castings, bronze or brass forgings, heavy gage sheet metals, structural steels, plastics and resin-impregnated plywood.

2 "Pentap"... the new, Improved P-K Type B-F*

(formerly F-Z) combining the five thread-cutting flutes of the Type F screw with the coarse-pitch, widely-spaced threads of the P-K Type B. The thread-cutting "Pentap" Type B-F distributes cutting pressure evenly, lets chips drop to the bottom of the hole, and prevents cracking of material. It is designed for making fastenings to comparatively thin sections and bosses in friable and brittle plastics.

3 P-K® Type L†

. . . is a completely new and improved thread-cutting screw developed by Parker-Kalon especially for use in Nylon. The Type L functions as a combination thread-cutting and thread-forming screw in that it cuts a small amount of the Nylon to allow the full diameter threads to form. Type L offers a particular advantage in Nylon assemblies which must be disassembled for service, because *the P-K Type L can be removed and replaced without stripping or galling.*

The five cutting flutes on the new, improved P-K Type "F" and "BF" reduce pressure development by 80 percent! The completely formed threads on these screws have sharper cutting edges, and 5 deep flutes that are of continuous depth. These features make for better clearance of the accumulated material and assure minimum stresses in driving, and avoid the possibility of stripping or galling.

FOR SEMS . . . and Neoprene or Nylon washer **STAPS®** in thread-cutting and thread-forming tapping screws, or machine screws in any kind of pre-assembled fastener-washer combination. P-K can supply them, too!

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*Patent Pending †U. S. Patent 2,350,346

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LXS is available with straight or offset sidebars. For details, contact your nearest Link-Belt office. (See CHAINS in the yellow pages of your phone book.) Ask for our new, comprehensive Catalog 1050.

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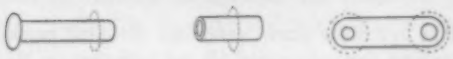

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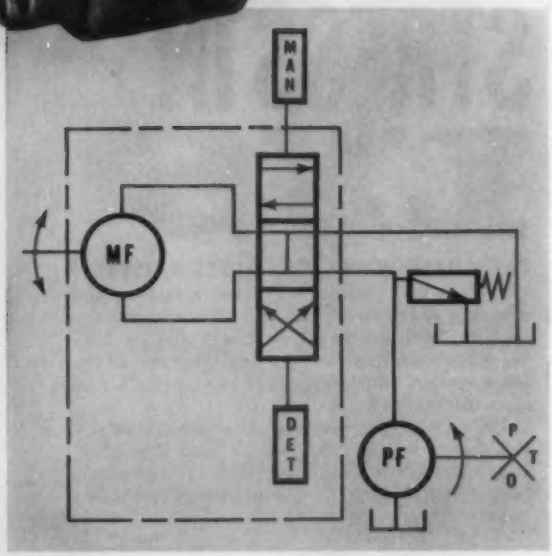
Super quiet hydraulic components hush unique refuse loader

A Model H hydraulic pump generates the fluid power which energizes the motor and all the cylinders on this continuous loading and compacting refuse collector—the Roto-Pac produced by City Tank Corporation of Corona, New York.

80 decibels of sound

Municipal specifications demanded a quiet-running pump—maximum noise level 80 decibels when measured 34 inches from source. COMMERCIAL's Model H Pump meets this requirement handily and delivers constant volume at over 90% efficiency. The reason: precision-ground matched helical gears, oversize bearings, protected leak proof seals and patented thrust plates team up to maintain positive internal alignment—prevent seizing—dampen shock and reduce noise.

ROTO-PAC'S continuous loading and tighter compaction results in ⅓ more payload—cuts collection costs.



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FROM WASHINGTON . . .

Don't look for sweeping changes in the NASA

In his State-of-the-Union message to Congress, President Eisenhower said the present law was "deficient in certain particulars" and changes would be recommended to Congress.

The proposed changes, however, are minor in scope. A move will be made to streamline powers of the NASA. The changes would cut the size and number of NASA's advisory committees. **Changes in NASA's patent law are expected too.**

Critics of the nation's space program won't be satisfied, however. Although the Administration says the changes will speed up space decisions, the White House won't cite examples of how the committees have caused delays.

Congress may plug for more drastic changes. Rep Overton Brooks (D. La), chairman of the House Space Committee, foresees "major changes" in the space law. But, Brooks isn't ready now to spell these out.

Hearings on the nation's space program scheduled to begin on Jan 20, seem to promise a major investigation. But observers caution that much of the space talk will be aimed toward political effects—a bid by Democrats to give the Administration a black eye. **For this reason, it is believed, Dr George Kistiakowsky, the President's science advisor, has declined an invitation by Brooks to testify.**

NASA will ask Congress for $23 million in supplemental funds for fiscal 1960. Some $19 million of this will go for the man-in-space program, Project Mercury.

Initial Polaris firing scheduled for late February

The Navy, reportedly, will fire its first Polaris missile from underwater in late February. **Firing site: the Pacific missile range in California.** Up to now, Polaris test vehicles have only undergone air-ejection tests from underwater launching tubes. The new tests will be at short range—only a few miles—but this time the missile itself will be ignited.

Submarine firings will begin between April and July from the nation's first Polaris-carrying nuclear submarine, George Washington (*PE—Feb 23 '59, p 21*). These tests will be made at the Atlantic missile range with test vehicles capable of traveling 900 miles or more.

Navy claims the Polaris missile has pinpoint accuracy. On Jan 7, the first fully guided test vehicle was fired 900 miles at Cape Canaveral. The missile, dubbed A-1-X-7, far exceeded guidance-accuracy predictions. An MIT analysis of the shot likened it to throwing a 4-in. dart the length of a football field and hitting a penny.

Titan missile faces congressional attack

The Air Force's recent charge that The Martin Co, prime contractor for Project Titan, "failed to follow authorized test procedures," probably will have repercussions in Congress (*PE—Jan 18, p 15*).

No successful firings have been made since last May 4; what's more 7 of 31 test vehicles have been damaged in handling or static tests—2 beyond repair.

Military officials claim there is no plan to cut back or kill the project. However, there is no question but that it faces its toughest test for survival in the next few months in Congress. Nearly $2 billion has been spent on the missile, with several hundred million more earmarked this year. Adding to the troubles of the Titan program are the optimistic reports about the readiness of the Atlas ICBM.

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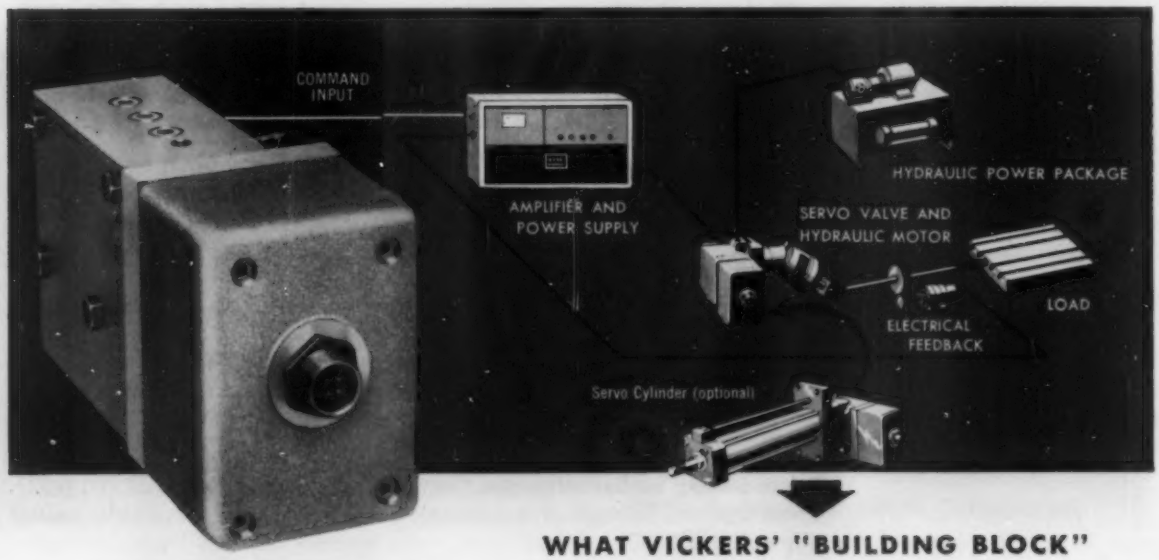

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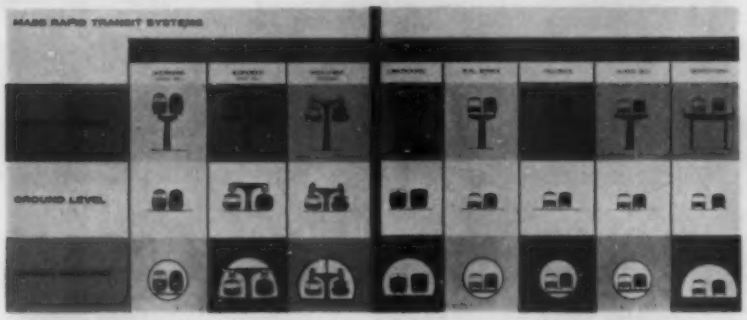
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

THE ENGINEERING WEEK



URBAN RAPID TRANSIT can take variety of forms. Basic methods are illustrated by Los Angeles engineering and architectural firm—Daniel, Mann Johnson & Mendenhall—that is now exploring all possibilities for the Los Angeles Metropolitan Transit Authority.

THREE BASIC MONORAIL TYPES—classic suspension from a single rail (top); saddlebag cars riding a beam (center); and split rail (bottom). The Wuppertal (top) is grandfather among suspended trains. It was designed in 1896 and completed 1903. Slightly more than 8 miles long, this German line carries 86,000 passengers daily; has cat-type bogies composed of running wheel and driven wheel with worm gear. Saddlebag is the Alweg experimental model. Each car is 36 ft long, 9 ft 10 in. wide and 13 ft high. Cars have two bogies, each with one driven supporting axle. The French split-rail cars are 56 ft long, 10 ft 1 in. wide and 9 ft 9 in. high. With maximum passenger load, cars weigh 22,000 lb, including 6300 lb of mechanical and electrical equipment and 7900 lb of structure. Cars are driven by 2 bogies with 2 driving axles. Cost is estimated at $3.5 million/mi, with rolling stock.

THE MONORAIL STORY:

Exotics Move In To End Metropolitan Paralysis

NEW YORK—Competition among designers of monorails is becoming intense. Transit authorities in many of the world's major cities—San Francisco, Los Angeles, Tokyo—are casting about for practical ways to move multitudes of people. They are comparing various rival possibilities: busses, conventional railways, monorails and other exotics (*PE*—Apr 7 '58, p 19).

Though the big customers are uncommitted, now is a great opportunity for proponents of monorails, who have been trying to gain acceptance for years without success. And many are now busily building prototypes and preparing engineering presentations. For example:

The Swedish-born industrialist, Dr Axel Wenner-Gren, installed a model of his saddlebag monobeam in Disneyland last year. This Disneyland system is closely patterned after an experimental line Wenner-Gren built near Cologne, Germany in 1957. The cars are slightly smaller than would be required for rapid transit, but the Disneyland line is regarded as a serious prototype, not a playland novelty.

This month, also, two French companies completed an experimental line near Orleans, France. They have submitted plans to the San Francisco Bay Area Rapid Transit Authority. The Authority says these are the only complete engineering studies yet received and look good. The French firms are Société Lyonnaise des Eaux et de L'Eclairage and Société Anonyme Francaise d'Etudes, de Gestion et d'Enterprises (SAFEGE).

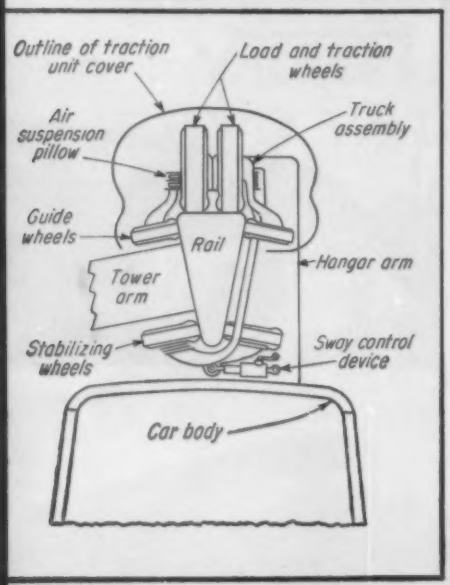
Goodell Monorail of Houston has a prototype line running in Dallas and is developing a new, simplified concept which is claimed to have "no apparent moving parts." Ground for a 1000-ft test line was broken last week.

In the US, Lockheed Aircraft, General Dynamics, and St Louis Car also reportedly have ideas on the drawing board. Lockheed has been named prime contractor for a monorail to carry visitors from downtown Seattle to the Century 21 Exhibition grounds when the fair opens in 1962. Lockheed's system is similar to the Alweg, but will use rubber-steel laminated wheels similar to those on streetcars instead of pneumatic wheels.

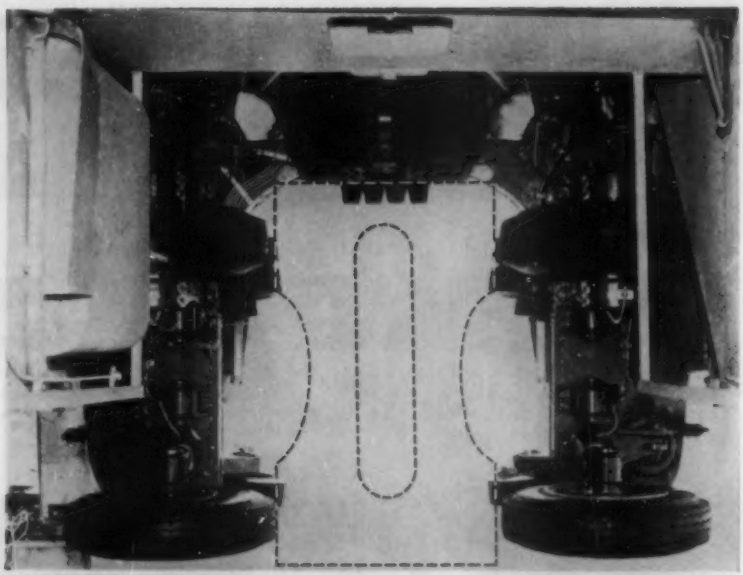
If any of the monorail creators should win a contract for rapid transit in a major city, the prize would be substantial. Los Angeles, for example, expects to spend $200 million initially and $800 million with later expansion. San Francisco will have a $600 million transit bond issue up for approval in November.

THE FRENCH TOUCH

The new French system is suspended from a split-box girder that allows the car to hang symmetrically below. Actually, it is not a true mono-



CONVENTIONAL MONORAIL, designed by Murel Goodell of Houston, is suspended from a triangular track, 22-in. wide and 42-in. deep. Each traction unit has four load (running wheels) that run on top of the rail; and six stabilizing wheels—two upper and one lower on each side of the track. Coach suspension is by air springs and torque bars. The air springs also serve to keep coach floor at constant level.



UNDERCARRIAGE OF THE ALWEG, supported monorail has 2 vertical carrying and drive wheels that ride atop the reinforced concrete beam; and 4 horizontal guide and stabilizing wheels that hug sides of the beam. The wheels have standard-dimension pneumatic tires. The small-dia wheels—4 at top and 2 on each side—are hard-rubber safety wheels.

rail. In the genuine item, the car is suspended asymmetrically from a single track such as the Wuppertal River line in Germany. The San Francisco Rapid Transit Authority refers to the French car and its beam-riding relatives as "exotics."

The French, some transit specialists believe, have solved two of the chief problems bedeviling suspended monorails. These are sway and oscillations that occur when a car is caught in a crosswind or when passengers shift from one side to another; and changes in height of car that occur when passengers enter or leave. The French solution is a double-pendulum suspension system. (See illustration.)

The two bogies for the cars are direct descendents of the bogies that have carried passengers on the Paris Metro. Each bogie has two drive axles, both powered by 3600-rpm, 100-hp, 750-v traction motors. The propulsion units drive a fully loaded train weighing 29.7 tons at a top speed of 62 mph with maximum acceleration of 6.5 ft/sec^2.

Another problem apparently solved by the French is switching. In a city like San Francisco, a peak load of 40 trains an hour must be moved. Up to now says Keneth M. Hoover, chief engineer of the Bay Area Rapid Transit District, no suspended system has shown this capability, but the French system comes close: "We think it has given us a more realistic approach than anything else we have seen so far."

GERMAN SADDLEBAG

Dr Wenner-Gren, the leading proponent of supported systems, began operating a full scale prototype near Cologne in 1957. The cars ride over an I-shape, reinforced concrete support beam measuring 4 ft 7 in. high and 2 ft 8 in. wide. Conductor rails run along the indented portion of the support beam.

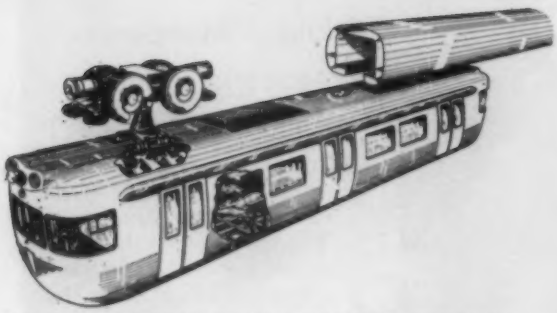
The Disneyland train is closely patterned on Alweg concepts and includes 3830 ft of track and a 500-ft maintenance spur. Topography of the road included 7% upgrades, 6% downgrades and curves of 120-ft radius. Its sponsors are of the opinion that 11% grades will be possible on urban systems.

Much of the Disneyland equipment is standard. Each car is driven by two 50-hp dc traction motors. These Westinghouse motors drive through a flexible coupling manufactured by Dodge. The coupling helps absorb shock of starting torque.

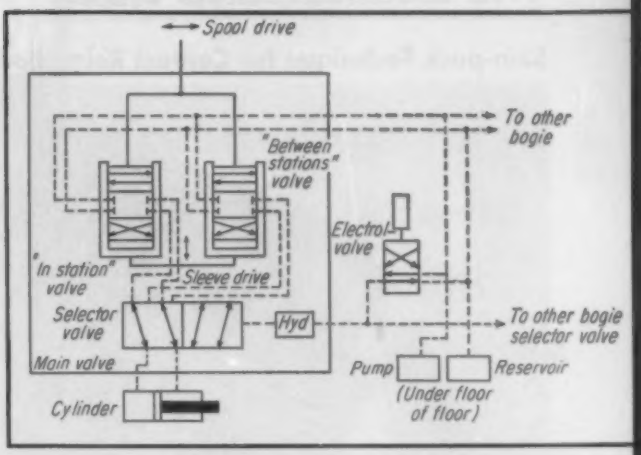
Coupling rails on sides of the beam

Secrecy Shrouds Texan's "Project X"

With one monorail already running in Dallas (see above), Murel Goodell, Houston's advocate of monorails for mass transportation, claims he has discovered a revolutionary new system. He declines to reveal design details for "patent reasons," but says that this radical system has "no apparent moving parts"; is based on two of the oldest known physical principles, never before combined for mass transit; is "financially, psychologically and physiologically" sound. Passengers would be carried inside a 7 x 7-ft enclosure whose upper half is transparent. It will be supported by steel towers, 15 to 40 ft high at 200-ft intervals. His system, Goodell says, is not a moving platform, but all mechanisms are confined to center of rail at bottom of the enclosure. A prototype is now under construction in Houston. An actual operating system, will cost $400,000 a mile. ■



SPLIT-BOX GIRDER, in which bogie of the French suspended train rides, exploits low stress inherent in hanging vehicles. Internal cross-section of the girder is almost square. Its shape puts torsional center about 2 ft above the beam. Because the car suspension system is designed to put rotation center near torsional center of the track beam, twisting forces are minimized and the structure can be light. Support structure weighs about 500 lb per foot; spans are about 100 ft long.



are steel-and-copper bus bars carrying 300 v. Power is supplied to 5 points along the main track by a 600-amp, silicon-diode rectifier which drops 440 v ac to 300 v dc.

Bogies are suspended by a Smithway unit similar to those used as "fifth wheel" on tractor trailer rigs. A rubber ring is added to absorb shock between bogie and body. The side wheels for guiding and stabilizing include an Alweg-designed, rubber-steel spring with variable spring rate—resistance increases nonlinearly with deflection. The weight-carrying drive wheels are Michelin steel cord, similar to those on the Paris subway.

THE EASTERN TOUCH

Tokyo has a 1094-ft monorail running through the city's Ueno Park. It opened November 1957 and is said to have carried nearly 7000 passengers a day since then. The line is regarded as an experiment that may serve as basis for a transit system between Tokyo and its satellite cities.

Cars are driven by two bogies, each with 2 pneumatic drive wheels and 4 stabilizing wheels. (Two cars compose a train.) Lateral vibration is controlled by a system of rubber-and-steel springs. The beam, along which the bogies ride, are square steel forms indented at top. Two conducting rails are fitted to the bottom of the beam and a pair of Z-shape pantographs collect current for the motor. Driving and control apparatus is at top of the car. The main, 300-v-dc motor has an output of 30 kwh and delivers 1600 rpm. Current is supplied by a 600-v distributor at the terminal. ■

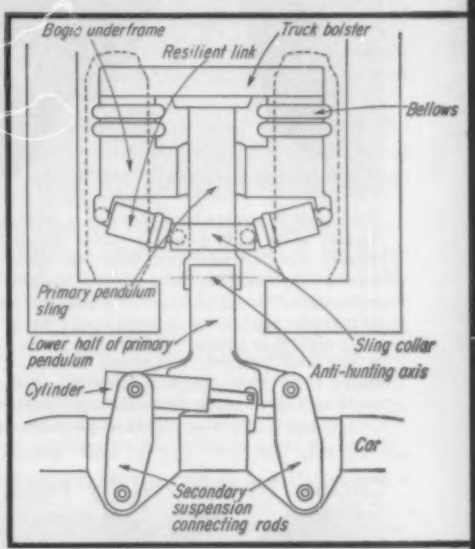
CAR SWAY AND ELEVATION AT PLATFORM, two problems that confound designers of suspended cars, are handled by a double-pendulum suspension system in the French split-rail concept. A disturbing force, swinging the car out of position, is sensed in the primary pendulum and a hydraulic cylinder in the secondary pendulum system rotates the car in the direction of swing to set up a restoring moment that counteracts the disturbing force.

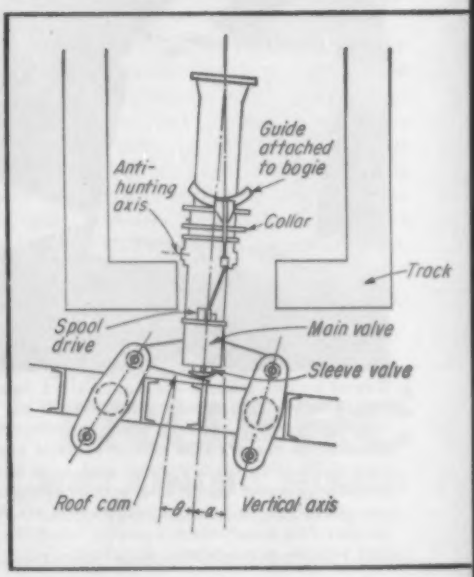
Primary pendulum sling attached to track bolster rides in a collar that is attached to bogie by two resilient links. These links restrain movement of the primary suspension system only when lateral forces exceed 2200 lb. Primary pendulum system rests on two bellows that keep car at constant height.

Restoring moments set up by swing of primary suspension sling are increased by action of secondary pendulum suspension. 7-ton hydraulic cylinder rotates top of car in direction of swing when on open track to counteract disturbing force. In station, cylinder rotates car opposite to swing to place car in a vertical position.

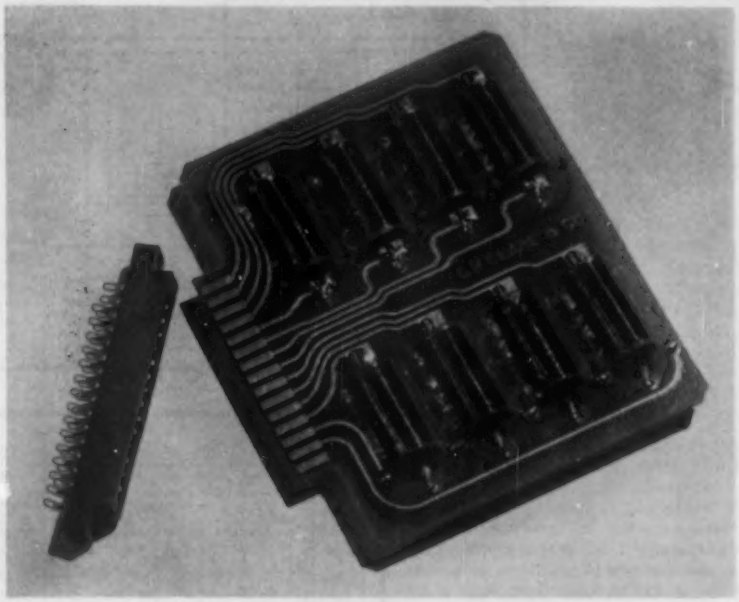
Main control system has only hydraulic and mechanical elements; is mounted on front side of primary sling. Block has three elements; two linear valves, one for "between stations," one for "in station" and a selector valve. Spools of the first two valves are driven in opposite directions by linkage attached to bogie; valve sleeves are driven in same direction by cam attached to the car roof. As a result, flow through the "between station" valve is a function of the difference between the sling inclination angle (α) and the angle between the car and the sling (β).

The selector valve ports either the "between station" valve or the "in station" valve to the cylinder, depending on the selector valve position. To keep the selector valves of both bogies synchronized, positions are controlled by the single electro-valve.



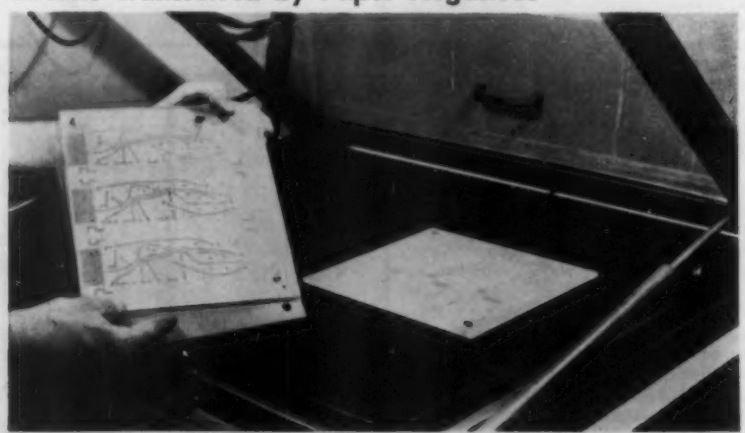


Skin-pack Technique for Contact Relay Board



Clear plastic covers both sides of a printed-circuit board—on which are mounted contact units—and protects solder connections, relay contact envelopes, and the printed circuit itself from dust and moisture. C P Clare & Co, Chicago, reports cost is less than 10¢/board, little weight is added, and board thickness is only increased 0.01 in. After soldering contacts in place, board is coated with a temperature-sensitive cement and placed in oven. A 5-mil vinyl or mylar polyester plastic is supported over the board; 300-F oven temperature causes plastic to sag and cement to become sensitive. Simultaneously, a small vacuum is drawn from reverse side of board and the plastic sheet is lowered onto board. Bonding takes place immediately. Same process is followed for reverse side except small holes are drilled to allow use of vacuum technique. Each side takes no more than 15 sec to package by this method.

Circuits Transferred by Paper Negatives



Use of a thin, translucent paper stock bonded to a rigid piece of a transparent plastic is recommended by Librascope Inc, as a highly effective means of transferring circuitry patterns onto copper-clad glass-epoxy laminated boards. Pins inserted in the corners of the templet correspond with predrilled holes in the sensitized circuit-board stock and hold board firmly in alignment during photographic process. According to Librascope, process reduces alignment and damage problems, and insures dimension stability of the negative. Ordinary photographic-film negatives are overly sensitive to temperature and humidity changes and require extra-careful handling.

Technical Manpower Increases in Industry

WASHINGTON — American business firms as of Jan '59 employed about 780,000 engineers and scientists—some 4% more than in Jan '58—the National Science Foundation reported here. This was about two-thirds of all the scientists and engineers employed in the nation. The remaining third worked for government, educational institutions, nonprofit groups, or were self-employed.

Industries with the largest groups a year ago were aircraft and parts, electrical equipment, and chemicals and allied products. Each employed more than 75,000; combined they accounted for a third of the total engineering manpower in private industry and about half the scientists and engineers engaged in research and development activities in private industry.

Each of two other industries—machinery (except electrical) and engineering and architectural services—employ more than 50,000 but less than 75,000 engineers and scientists. Next in size, in terms of engineering manpower, were construction, fabricated metal products and ordnance, primary metals, and motor vehicles and equipment. Each employed more than 30,000 but less than 50,000 engineers and scientists.

Engineering employment increased from about 605,000 in Jan '58 to 630,000 in Jan '59, while scientists in private industry increased from 145,000 to 150,000. ■

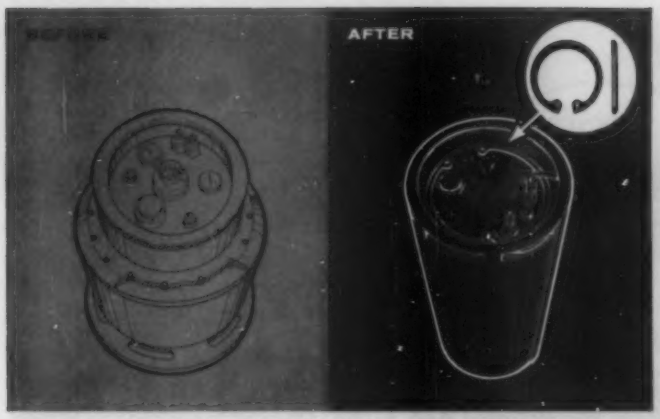
Tiny Turbojet May Power Light Aircraft

DETROIT—A turbojet engine weighing 23 lb and producing 70 lb of thrust may bring jet power to the light-plane industry. Developed by Williams Research Corp, the engine is called "the world's smallest turbojet."

Williams engineers say the new engine incorporates many of the low-cost elements from their recently developed, lightweight gas-turbine, which operates on the heat-exchange principle (*PE*—Nov 23 '59, p 40).

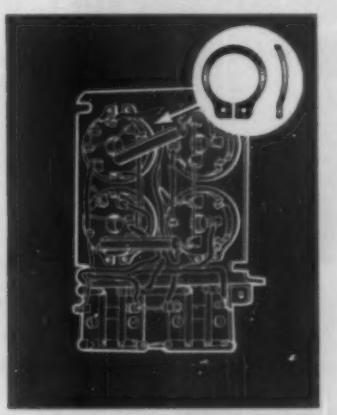
The engine, powered by a 4-to-1 centrifugal compressor, an annular combustion chamber and a single-

continued on page 20

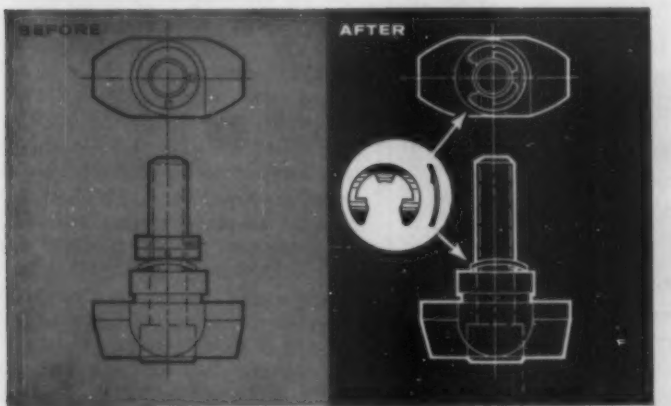


Pressure cover design simplified. Two axially assembled Truarc Series 5002 beveled rings eliminate 27 bolts, reduce machining and assembly time from 78 to 1½ hours and make possible drastic size and weight reductions. Rings retain two covers of a pressurized x-ray unit. **Savings: about $500 per unit.**

Parts eliminated in slide assembly. Two radially assembled Truarc Series 5139 Prong-Lock® Rings provide proper spring tension, eliminate looseness and wobble in this office calculator shift-slide. Original design called for a cut washer, spring washer, and cotter pin—all eliminated.



New way to install electron-tube sockets. Easy-to-apply Truarc Series 5101 bowed external rings lock tube sockets to chassis plate in this assembly. Bowed construction takes up tolerances of molded grooves, thickness of base. Individual sockets are removable for field service.



Quarter-turn clamp improved. A bowed washer and two locknuts were eliminated in this quarter-turn jig-and-fixture clamp by a Truarc Series 5131 bowed E-ring. The radially assembled ring holds the screw captive, provides required rotational drag between parts with sufficient tension to insure tight fit when the screw is first engaged. **Typical savings: $1.35/unit—assembly up 70%.**

Truarc rings for end-play take-up offer significant design advantages

A number of Truarc retaining rings are available to take up end-play or loose fit caused by accumulated tolerances and wear. The rings often eliminate spring washers, collars and set screws, nuts, bolts, rivets, cotter pins and other conventional fastening devices with outstanding cost savings in machining and assembly time.

Truarc retaining rings designed to deal with the end-play problem are of two general types: **bowed rings** for resilient end-play take-up and **beveled rings** for rigid end-play take-up.

Bowed retaining rings are widely used for preloading bearings, preventing vibration or oscillation in linkages, providing tension on adjusting screws. Of particular interest is the radially installed Truarc Prong-Lock® ring which locks securely to the shaft by means of two prongs. It provides exceptional thrust load capacity, may be used as a shoulder against rotating parts, and often eliminates springs, bowed washers and other tensioning devices.

In beveled rings for rigid end-play take-up, the groove-engaging edge is beveled at 15°. There is a corresponding bevel on the load-bearing groove wall. To take up end-play, the ring acts as a wedge between the outer groove wall and the part being retained.

These are just a few of the 50 functionally different types of Truarc retaining rings. They come in up to 97 standard sizes, six metal specifications, 13 different finishes. The entire line as well as accessory assembly tools, grooving tools, and over 70 typical applications are shown in the new catalog RR 10-58. Write for your copy today. And remember Waldes Truarc engineers are always ready to work with you on your specific projects. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N.Y.

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WALDES
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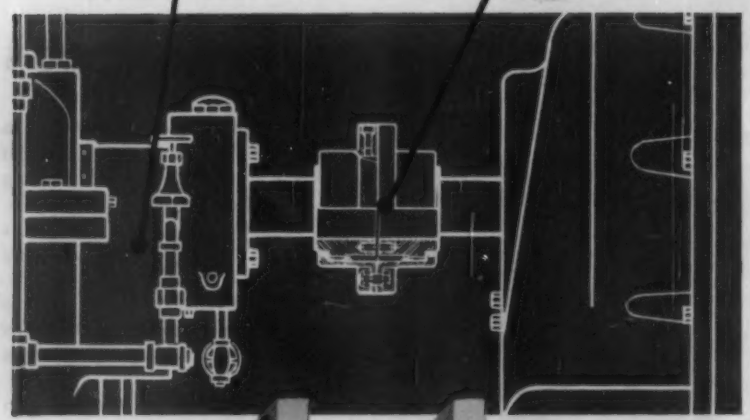
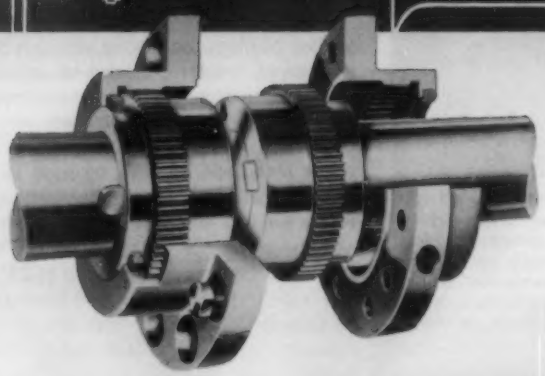
RETAINING RINGS
Waldes Kohinoor, Inc., Long Island City 1, N.Y.

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

FOR
"AS DESIGNED"
PERFORMANCE
HERE

SPECIFY
WALDRON
COUPLINGS
HERE





When a lot of time and effort have been put into the design of a driven unit, it makes sense to protect its operating efficiency with a good coupling.

Waldron gear couplings are available in a wide range of standard and special types for any service requirement, to provide complete protection and positive, trouble-free drive.

Deliveries are excellent. Rough bore standard couplings up to 6" sizes, already assembled, can be shipped from stock; others, to meet customers' schedules.

WALDRON Couplings

WALDRON-HARTIG DIVISION
MIDLAND-ROSS CORPORATION
P. O. Box 791 • New Brunswick, N. J.

continued from page 18

stage, axial-flow turbine, functions at 59,000 rpm. Although this high speed did not introduce any serious mechanical problems, much development work was necessary to achieve high aerodynamic efficiency with the miniature components.

The engine is well suited for light aircraft because it is small enough to be submerged in the wing contour and cheap enough to allow several units per plane. Multiple-engine planes present one major problem: they entail high takeoff and landing speeds that require too much pilot skill for a major market. However, numerous systems for short takeoffs and landings are being investigated by aircraft manufacturers.

Williams engineers also claim the engine mounted on the tips of helicopter rotors would give sufficient thrust to operate a four-place craft. It is also being tested as a power source for drones. ■

Purchasers Seek Closer Ties with Engineers

DETROIT—The role of engineering does not end with the design and specification of a new part, component or assembly. This was the consensus of purchasers from the automotive Big Three and a leading parts manufacturer during a panel discussion conducted at the Society of Automotive Engineers meeting here.

The purchasers asked engineers to take the following steps:

- Postpone engineering decisions until they are needed. A decision made too early is more likely to be revised—sometimes drastically. This complicates purchasing.
- Give Purchasing sufficient lead-time information so it can set up a progressive flow of parts. This includes time for suppliers to plan and tool for production.
- Supply Purchasing with adequate designs and specifications. These should be based on consistent producibility and commercially recognized specifications.
- Recommend possible sources without imposing restrictions. Often the engineers are the only ones aware of new developments and capabilities in established as well as new sources.
- Suggest alternate suppliers and alternative materials, processes, etc., that

would produce satisfactory parts.

• Avoid a "hands off" policy just because a particular component has never given excessive trouble. Even established designs can be improved.

• Keep Purchasing informed on development programs so it can prepare for the problems ahead. This would save time when the development is concluded and production starts. ■

Misdirected R & D Threatens Weapons

WASHINGTON—In the glamour of many large weapon systems, R & D for components often has been overlooked. That charge was made by Rear Adm J. T. Hayward, Assistant Chief of Naval Operations, at the 6th Annual Symposium on Reliability and Quality Control in Electronics.

Although it has been easier to get money for large systems, he continued, results indicate that we should pay more attention to our homework on components—and this year the Navy will spend more of its R & D money for this purpose.

The keynote speaker, J. K. Sprague, president of Sprague Electric Co, supported this view. Too much R & D has been concentrated on "breakthrough" research aimed at specific applications, he said, and not enough for increasing the reliability of standard parts and materials.

The Dept of Defense, he said, must stress the importance of quality and reliability. Sprague called for complete, uniform specifications, without loopholes that allow clever individuals to compromise reliability in the interest of lower costs. The practice of waiving test requirements and lot-by-lot control to reduce costs is "very widespread today," he said.

As a remedy Sprague suggested modified competitive bidding, with suitable restriction on those contracts that require high reliability. He also called for revision of qualified products lists to assure that listed products continue to meet requirements, and for maximum standardization of highly reliable components.

A third speaker, Edward F. Howry, former chairman of the Federal Trade Commission, pointed out some pitfalls of the antitrust laws. Even when product standardization, simplification, and grading programs are not purposefully illegal, they serve as circumstantial evidence of illegal agreement. ■

BINDING OF RAW EDGES of cuttings or punchings?
. . . an important detail and one where experienced skill is worth buying.
For many uses the cut or punched piece of wire cloth is only partially completed. It's like laying a brick wall without pointing up. What about the edges? What's the best way to seal off or close in these protruding wire ends to prevent snagging or injury.
Illustrated here are several methods we have perfected. In this selection, much depends upon the end-use of the insert piece and conditions under which it is to function.
When you place an order with us for a quantity of cloth pieces regardless of cloth, mesh, size, etc., and would like our recommendation as to the best binding, give us the details of end-use. We'll be glad to give you the benefit of our broad experience in edge-binding.
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Types of edge bindings illustrated are: brazed, spot weld, spun, soldered, fused plastic taped, wire cloth, and U-binders.
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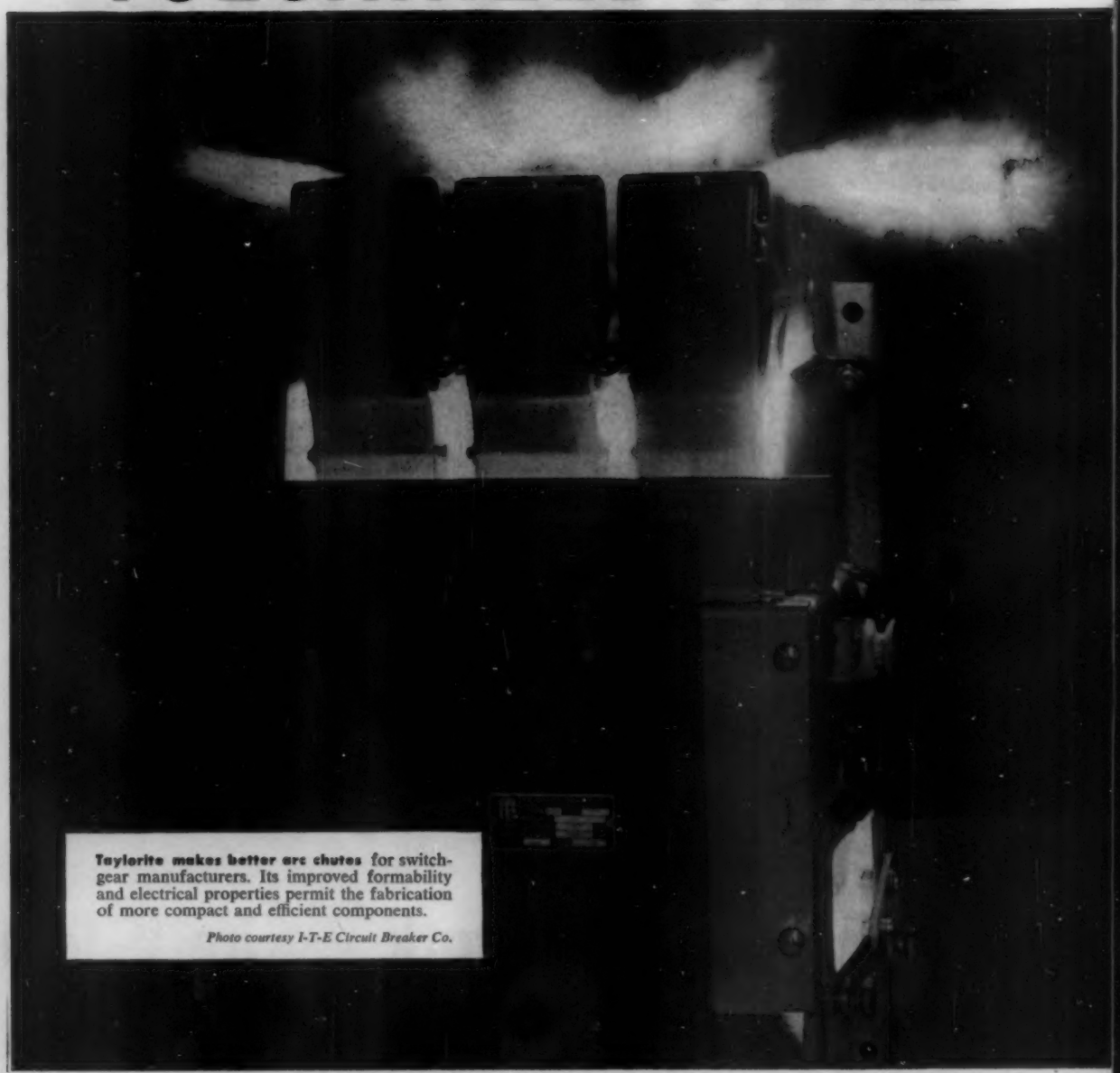
CIRCLE 21 ON READER SERVICE CARD

"TAYLORITE"®--THE NEW NAME FOR IMPROVED VULCANIZED FIBRE



Taylorite makes better arc chutes for switchgear manufacturers. Its improved formability and electrical properties permit the fabrication of more compact and efficient components.

Photo courtesy I-T-E Circuit Breaker Co.

Our vulcanized fibre is so improved that we have given it a new name. Better electrical, physical and mechanical properties, and greater uniformity from lot to lot have made this workhorse material even more adaptable to a broad range of applications throughout industry.

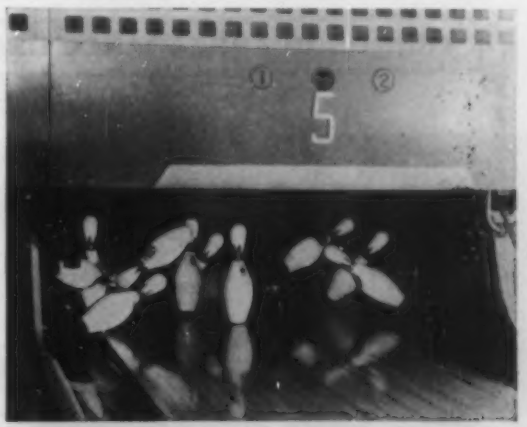
New Taylorite commercial grade, for example, has greater tensile strength, greater flexural strength, greater compressive strength, and greater dielectric strength than the older commercial grade. It is extensively used in the electrical industry. Its high impact resistance, good formability, toughness, and ability to be deep drawn make it an ideal material for 1001 industrial applications. Samples are available. Test them for yourself. Put them under tension, flex them, compress them, form them. You will find Taylorite passes your severest tests with flying colors. And remember, Taylor offers you complete design and engineering assistance.

Data Sheet 2-0 gives complete technical information—write for a copy and for samples today. Taylor Fibre Co., Norristown 39, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

Taylorite offers new flexibility, ply adhesion, tear resistance, resilience and toughness to manufacturers of abrasive discs and drum sanders. Also uniform abrasive distribution.

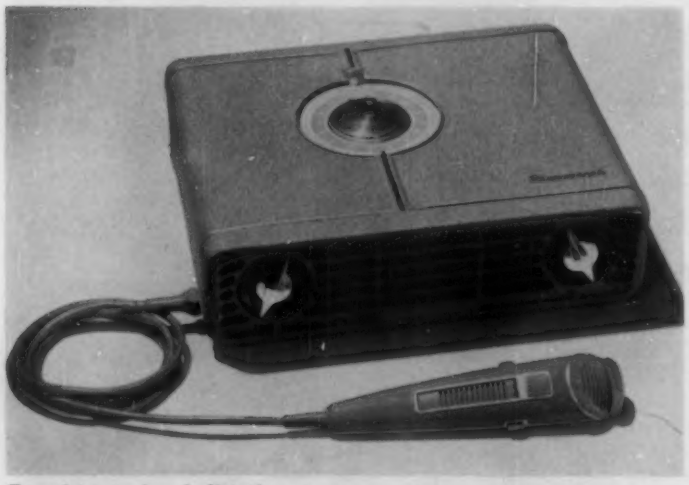


Taylorite provides new impact resistance and toughness in many structural and mechanical applications. Typical of these is its use as kick back plates in bowling alleys.

Taylorite's improved electrical properties, impact resistance and high uniformity from lot to lot make it ideal for such vital applications as railroad track and switch insulating parts.

Typewriter frame and base are integrated into easy-to-clean, easy-to-disassemble unit that also forms lower portion of carrying case. Base and cover, with indentation for handle, are of reinforced polyester by "gunk" molding process. By L. G. McIntosh, Toronto for Commodore Typewriter Co.

TRENDS IN APPEARANCE DESIGN . . . *in Canada*



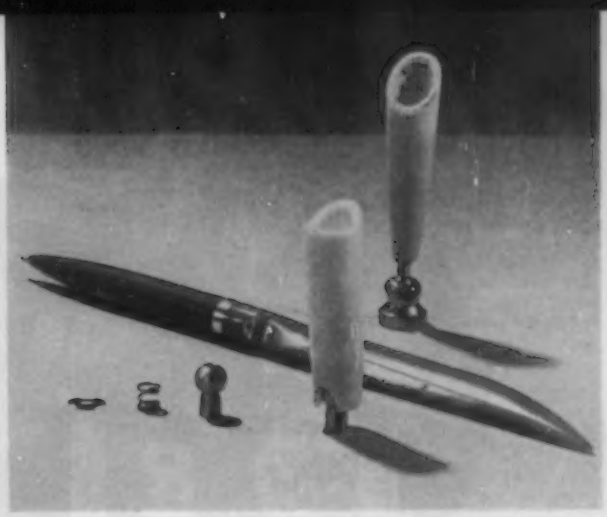
Transistor-equipped dictating machine, above, is the first completely engineered and designed in Canada, but it is being manufactured at present in the US. Both machine and microphone housings are magnesium; unit weighs 11 lb. By Ensor Industrial Design Associates, Toronto, for Sonograph Ltd.

For servicing in cramped quarters aboard small vessels, sleeve-type housing provides maximum accessibility for repair of radio-telephone (right). Knobs had to be capable of being identified with function and manipulated in the dark while wearing heavy gloves. By Finkel-Eveleigh Industrial Design, Montreal, for Canadian Marconi Co.

■ Canadian industrial design is coming of age and developing its own identifiable traits, despite two sources of strong pressure to imitate. First there is the homeland yearning, which causes many British-born Canadians to manifest more Britishness than the United Kingdom itself. Much more overwhelming is the impact of US design and the appetite for it created in Canada by advertising of American products. The sophisticated Canadian shopper would settle for nothing short of the US standard—often at a premium price not justifiable in terms of value received.

As for the Canadian manufacturer, original product design generally seemed a luxury he could ill afford. While his distribution problem was at least as complex as that of his US counterpart, his market was a tiny fraction of the US potential—for example, the initial sampling order for a new product in the US may equal the total exploitable Canadian market for the same item!

But opportunities for the Canadian designer to show what he could do have



To help minimize tooling costs, Finkel-Eveleigh Industrial Design, Montreal, eliminated one component in the stand for this ballpoint desk pen (new three-part mechanism at left, front). To broaden sales potential, combination letter opener and ruler was incorporated into handle. Made by National Pen Co.

Hull of this 17-ft-long, outboard catamaran is glass-reinforced plastic, with foam-filled compartments. By Hugh A. Dodds, Oakville, Ont, for Aero Marine Industries. American boats aren't the only victims of the Detroit fin disease.

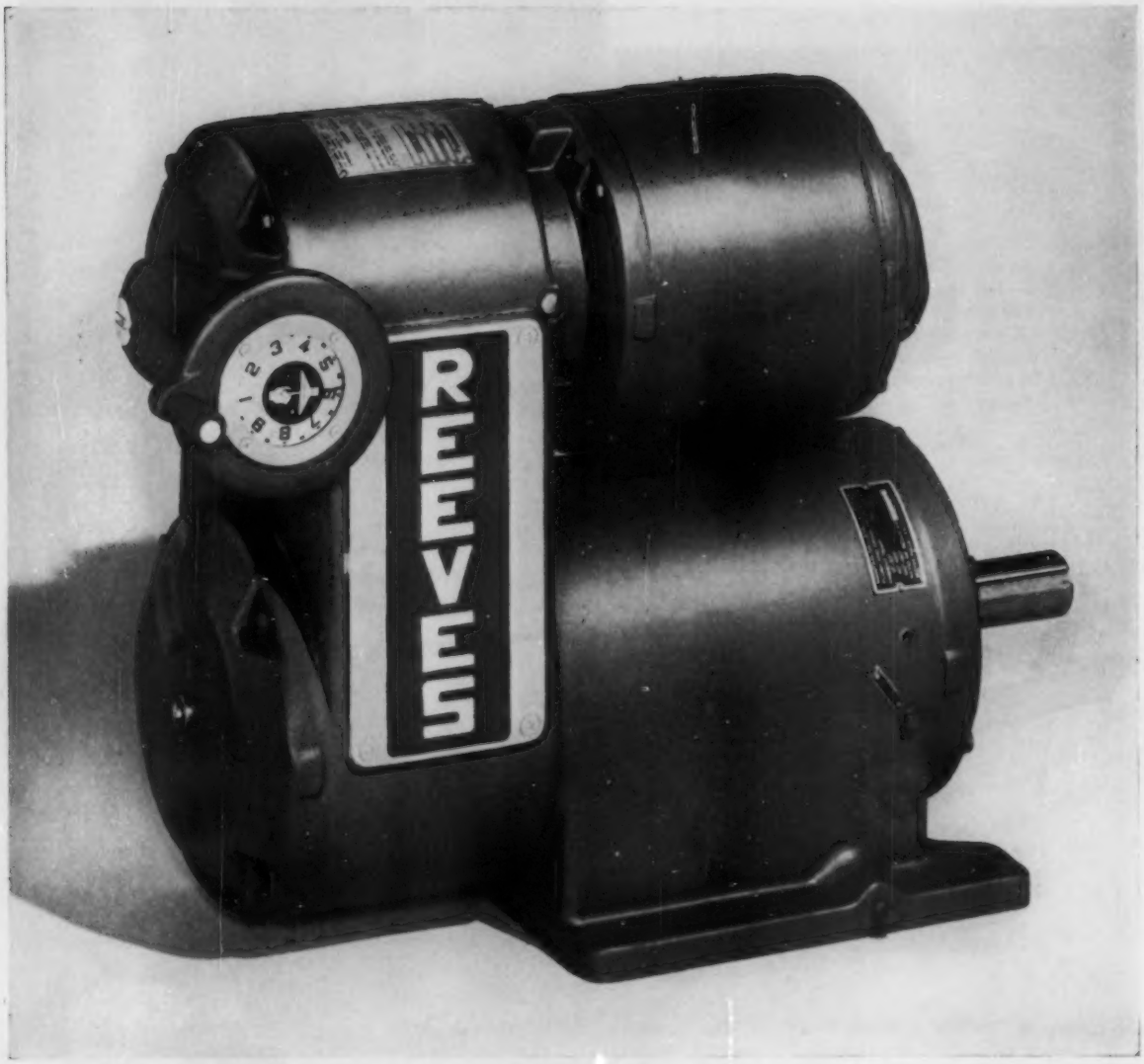
now developed. The end of World War II left Canada with much new manufacturing capacity, but no peacetime markets large enough to absorb any great increase in the flow of manufactured products. This vacuum has now been filled. Much of the job of awakening demand for new Canadian products has been done by the industrial designers.

"Fresh design" is the concept these designers have been pushing, by which is meant having products engineered and designed by those best equipped to fulfill the demands of Canadian tastes and functional requirements. This concept is being urged on Canadian industry as the best answer to foreign competition and as a profitable alternative to copying and imitating. And these efforts have borne fruit, because the last ten years have seen a steady growth in the use of industrial design service, as well as in expenditures for product development. As a result, today there is beginning to be available to the Canadian consumer a choice of domestically designed and produced brands and styles.

The 11-year-old history of the 50-member Association of Canadian Industrial Designers neatly parallels this development in the Canadian marketplace. Another organization in the field is the National Industrial Design Council, which is essentially a co-ordinating body with representation from the design fraternity, government, industry, retailing and consumer groups. There is no school of industrial design in Canada, although the Ontario College of Art does offer a course in the subject which has helped to generate design talent.

Slowly, as the Canadian industrial designer gains stature, recognition and imitation of his work is showing up outside the country. In fact, an old pattern is being reversed: there have already been some instances of design piracy, with Canadian designs finding their way southward across the border. More happily, some Canadian manufacturers have already enjoyed a gratifying bonus for investing in industrial design—royalties from their stateside counterparts for use of designs in the US. Michael Gutwillig

Graphic material placed under bottom opening of this reflector-type magnifying projector is reproduced on wall or screen. Designed by Sid Bersudsky, Toronto, for Peter-Austin Mfg Co, the projector has won awards in Canada and is now being made under license for distribution in the US.



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packed with new flexibility . . . broader production use

Now available in this compact design, Reeves Vari-Speed Motodrives deliver 2:1 through 10:1 speed variation, 1.8 through 4660 rpm . . . ¼ to 20 hp.

The infinitely variable output speeds meet almost every production need.

You can get these drives with output shaft on same or opposite side of the motor; vertical, 45°, horizontal or trunnion models; no reducer, and single, double or triple stage reductions . . . hundreds of space saving assemblies. Reeves provides a full range of modifications, accessories, and manual, remote or automatic controls. G-1639

Write today for complete data on sizes 100-500 (¼-20 hp) and sizes 8000 (25-40 hp)

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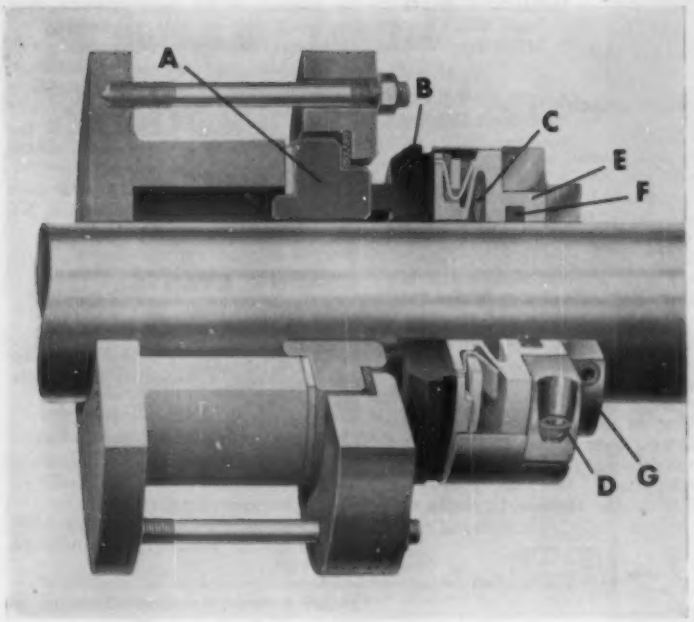

LAST LONGER IN CORROSIVE CHEMICALS

Garlock CHEMISEAL® Mechanical Seals have, through years of application, proved their ability to seal effectively against all chemicals . . . from the "easier" Methanol, Acetic and Propionic Acids to the more reactive Hydroxyacetic, Sulfuric, Adipic Acids and Hydrocarbon Slurry.

High-quality construction. The bellows unit of CHEMISEAL Mechanical Seals is, in all cases, made of chemically-inert Teflon†. Various materials are used for the sealing faces dependent upon the medium and service requirements. Referring to the illustration at left, the seal comprises a stationary face "A" secured to the stuffing box and a rotary face "B" which rotates with the balance of the seal mechanism and is secured to the shaft. Between these precision lapped faces a leak proof seal is accomplished by the spring loaded Teflon bellows section "C." Clamp "D" secures area "E" to the shaft with the help of the Hypalon or Teflon O-Ring "F," forming a drop-tight seal. Back-up collar "G" is an added precaution to prevent the seal from working out on the shaft.

There are other benefits, too, that CHEMISEAL Mechanical Seals can add to your particular application. Consider the fact that they offer a life expectancy many times that of other seals . . . don't score the shaft during operation . . . are easy to handle and install.

Solve your difficult sealing problems. Apply Garlock CHEMISEAL Mechanical Seals against all media—including solids in suspension—in pressures to 100 psi at 75°C, or 75 psi at 100°C. Standard sizes to fit all pump shafts from 7/8" to 2 1/8"; special sizes also available. Discuss complete details with your local Garlock representative, or write for Catalog AD-164. The Garlock Packing Company, Palmyra, New York.

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READER TO EDITOR

Gumperson's Law Explained

To the Editor:

In going through the October 12 issue, p 42, I noticed in the "Reader to Editor" column a reference to Gumperson's Law. The headline of the item entitled "Who's Gumperson?" leads me to believe that someone on your staff has not heard of this famous man.

In the spirit of cooperation and to render some small service in the field of education, I am delighted to clarify this question as follows: Gumperson's Law accounts for the fact that you can throw a burnt match out the window of your car and start a forest fire while you can use two boxes of matches and a whole edition of the Sunday paper without being able to start a fire under the dry logs in your fireplace.

The law, stated simply, is that the contradictory of a welcome probability will assert itself whenever such an eventuality is likely to be most frustrating. Readers familiar with these matters will perhaps recognize another version of the law—the outcome of a given desired probability will be inverse to the degree of desirability.

A brief elucidation of the law, with details on its origin and development, is presented for the benefit of the lay reader. Dr R F Gumperson began serious work in 1938 on a phenomenon long known to scientists but up until then considered as a mere curiosity. This was the fact that the forecasting record of the weather bureau, despite its use of the most advanced equipment and highly trained personnel, was not as good as that of the Old Farmer's Almanac. After four years of research, Dr Gumperson enunciated his now famous law and was able to make a series of predictions later confirmed by other scientific workers in the field. Some of the better known of these include the following:

- That after a raise in salary you will have less money at the end of each month than you had before.
- That the girl at the race track who bets according to the color of the jockey's shirt will pick more winners than the man who has studied the past performance of every horse on the program.
- That children have more energy after a hard day of play than they do after a good night's sleep.
- That the person who buys the most raffle tickets has the least chance of winning.
- That a child can be exposed to the mumps for weeks without catching them but can catch them without exposure the day before the family goes on vacation.
- That the dishwasher will break down the evening you give a dinner for ten.
- That good parking places are always on the other side of the street.

Dr Gumperson served as consultant to the armed services during World War II and evolved the procedure whereby the more a recruit knew about a given subject the better chance he had of receiving an assignment involving some other subject.

There is no knowing to what further glittering heights Dr Gumperson's genius would have led him had it not been for his untimely death in 1947. Strolling along the highway one evening, he was obeying the pedestrian rule of walking to the left facing traffic. He was struck down from behind by a Hillman-Minx driven by an English visitor hugging the left side of the road.

WILLIAM E BARTA
Louis Allis Co
Milwaukee, Wis.

Mechanical Reliability

To the Editor:

I read with interest your recent article on Reliability (Nov 16, p 27). With one or two exceptions I feel that the article is timely and should be well received. However, after owning and driving both American and European cars, I don't believe there is a great amount of difference in the quality. You still seem to believe the fallacy of 100% inspection and are blaming manufacturing and inspection as the major offenders for poor quality. Recently I heard of an analysis of engineering and manufacturing faults where engineering errors were in the ratio of two to one manufacturing error. If you have ever tabulated engineering change notices, this could be apparent.

In addition the formula for sigma is usually written:

$$\sigma = \sqrt{\frac{\Sigma (t - T)^2}{N}}$$

and the Gaussian

$$y = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(t-T)^2}{2\sigma^2}}$$

Aside from this, congratulations!

—H C CHARBONNEAU
Supervisor, Quality Control
General Motors Institute

Praises New Engine Concept

To the Editor:

In regard to the newly announced rotary-type combustion engine (Dec 7, p 44), I would like to mention that I am joining those who will praise the Curtiss-Wright Corp for its engineering breakthrough in designing more efficient and lighter internal-combustion powerplants. Besides that, I have a much higher appreciation for another breakthrough, which in my opinion is much more important—breaking through a mental barrier that so far has kept engineers from accepting the unique rotary-engine design concept as sensible or at least debatable.

Now that Curtiss-Wright and NSU have proved this prejudice was quite wrong, internal combustion, especially for automotive uses should enter a new era of better power-to-weight ratios and higher efficiency. Present engine concepts may soon become part of a glorious but low-economy past.

With the ice finally broken, more might be done and written about the Cinderella of IC concepts, the controversial rotary engine. Fuel consumption in these powerplants should soon drop to approximately 0.25 lb per hp-hr, idling to as low as 100 rpm with speed ranges extending up to 7 or 8000 rpm. Power-to-weight ratios, as proposed by Roy T. Hurley, will prove better than 1:1 and vibration will be nil.

Being well acquainted with other designs in the same general line as the Curtiss-Wright engine, I am convinced, that even the most favorable lobe-type design (in contrast to the more common vane type) will only be able to reach its full potential if developed in accordance with an especially composed cycle. This in itself would have to solve certain problems encountered with the positive-displacement rotary engine design concept and, at the same time, provide the thermodynamic base for increased process efficiencies.

—TED W BIRK
Stephentown, NY

COMING EVENTS

JANUARY

25-28 . . . . Plant Maintenance & Engineering Show, Convention Hall, Philadelphia.

25-28 . . . . Institute of the Aeronautical Sciences, 28th Annual Meeting, Hotel Astor, New York.

26-27 . . . . Society of Vacuum Coaters, 3rd Annual Meeting, Hotel Biltmore, New York.

31-Feb 5 . . . . American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York.

FEBRUARY

2-4 . . . . Society of the Plastics Industry, 15th Annual Technical and Management Conference, Edgewater Beach Hotel, Chicago.

3-4 . . . . Armour Research Foundation, 6th Annual Midwest Welding Conference, Illinois Tech Chemistry Building, Chicago.

3-5 . . . . Institute of Radio Engineers, 1960 Winter Convention on Military Electronics, Ambassador Hotel, Los Angeles.

10-12 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, Univ of Pennsylvania, Solid-State Circuits Conference Philadelphia.

24-25 . . . . Malleable Founders Society, Technical and Operating Conference, Cleveland.

Veeder-Root READOUT Bulletin

One of a Series

Predetermining Counters provide simplified methods for Automatic Control

Veeder-Root Predetermining Counters now make it possible to design and build automatic control into equipment of all types. They are available for mechanical, electrical and electronic control and offer many features and options to give your equipment extra value and versatility.

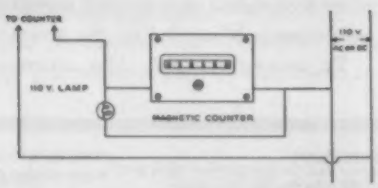
Predetermining Mechanical Counters can be applied to rotary, eccentric or stroke type motion, registering or counting whatever units are required — such as revolutions, motions, turns, pieces, lengths, and strokes. The newer electric and electronic Predetermining Counters use a special high speed light source and photo cell for non-contact counting on any machine or process.

Automatic control is provided by the predetermining counter actuating such devices as: lights, bells, signals and stop motions. They work at speeds up to 8000 counts per minute, can be easily incorporated into machine design and control panels. Application assistance is available from a Veeder-Root Counting Engineer; and specialized designs and modifications can be supplied in most cases. For complete information, call or write your nearest Veeder-Root office.

The High Speed Predetermining Counter is the basic counter in this complete line. It provides automatic control by this simplified method: . . . to set a run of 5451 pieces on the counter: (1) Set all white wheels to zero with one turn of wing-nut; (2) Now, set the metal wheels, one by one. Set first wheel to "5", opposite zero on its "opposite number" white wheel, then set the "4", "5" and "1" and that's all . . . you're ready to throw the switch and start the run.

High Speed, Quick Reset Predetermining Counters for electrical and mechanical control, at speeds to 8000 cpm.

This counter has one set of wheels which are preset to any figure within the capacity of the counter by depressing the reset lever, raising the cover, and turning. The counter subtracts from the preset number to "00000", when a knock-off lever actuates an electrical switch. To reset, just press the reset lever, and counter returns instantly to preset figure. For Mechanical Control, counter actuates a mechanical lever instead of electrical switch. Speeds: 6000 rpm or 8000 counts per minute.



Addition of Magnetic Counter Provides Record of Total Lots.

A Veeder-Root Magnetic Counter connected in series with the alarm or stop motion registers one unit for each of the predetermined lots produced. Provides a simple means to obtain both machine control and production control.

Electric Predetermining Counter Ideal for Batching, Length Measurement and Materials Handling.

This new counter offers automatic reset plus other important features: **1.** Instant automatic reset . . . Control contacts operate and hold for 0.3 seconds . . . or for 2 seconds . . . or indefinitely. **2.** Counter can be modified for automatic sequential predetermining, using two or more preset numbers. **3.** A batch or totalizing counter can be added. This counter is adaptable to material handling applications, slow speed batch counting, length measurement, slitting, and similar applications. Speeds up to 1000 cpm.

High Speed Electronic Predetermining Counters Feature Automatic Reset, 5000 cps.

The No. 1604 features instantaneous recycling. Up to six decade counters, with one, two, or more sets of preset numbers . . . with or without photohead or enclosure. Output relay provides momentary or indefinite holding time. Batch totalizing available. Ideal for all high speed counting, up to 5000 cps, recycle at 1000 cps.

Send for Literature and Technical Data . . . Extensive information and specifications on how to use Veeder-Root Predetermining Counters are yours for the asking. Send today.

Veeder-Root

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"The Name that Counts"

New York • Chicago • Los Angeles • San Francisco • Seattle
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Big Three's Little Three

to get Greater Strength for Maximum

Each time a trio of these new cars rolls off the assembly lines at Ford, Chrysler Corporation and Chevrolet, another set of 67 Malleable parts goes into action to give American drivers more dependability, convenience and economy.

Valiant, Corvair and Falcon Use Greater Proportions of Malleable Iron Than the Three Conventional Cars!

Brand new from tread up, the Corvair, Falcon and Valiant are the result of intensive investigation, engineering and testing . . . all done to produce lighter, more economical cars without sacrificing the safety and convenience demanded by the American public.

To accomplish this, the automobile industry's

These companies are members of the MALLEABLE CASTINGS COUNCIL

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
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New Haven Malleable Iron Co., New Haven 4

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Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
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National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

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National Mall. & Steel Castings Co., Indianapolis 22

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MASSACHUSETTS
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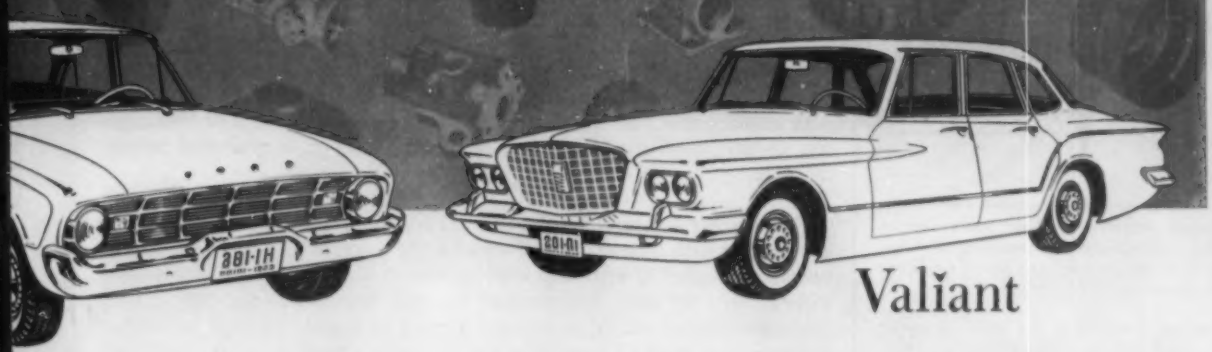
Rely On MALLEABLE

with Less Weight Operating Economy....



three newest creations use *more* Malleable in proportion to total materials than all other models of the same manufacturers. Why? Malleable provides *more strength per dollar* than any other metal, ferrous or non-ferrous. Malleable castings have *more strength per pound* than "light" metals. Being the *most machinable of all ferrous metals* of similar properties, Malleable speeds production . . . produces better parts. Malleable castings have proved uniquely dependable for critical applications in millions of cars now on the highways.

How many places are there in your operations where Malleable castings can improve your products and reduce your costs? Check now . . . send drawings or an outline of your requirements to any of the progressive Malleable castings producers who display this symbol—

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Union Commerce Building, Cleveland 14, Ohio

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Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
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WISCONSIN
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Kirsh Foundry Inc., Beaver Dam
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Off-the-floor angle iron caster operation is clean, practical and inexpensive

● Albion heavy duty V-groove casters offer greater utilization of floor space — easier, safer, more economical handling of heavy loads, protect flooring and speed production line operations.

Designed for use on inverted angle track — for any service requiring complete control of the truck or conveyor unit, Albion V-groove *self-cleaning* casters are also ideal for on-the-floor operation. And . . . only Albion offers a *complete* range of wheel sizes from 4", 5", 6", 8" and 10" diameters in full swivel or rigid models with a choice of wheel bearing types, capacities from 500 to 15,000 pounds and special features to suit your needs. Remember . . . specify Albion casters and wheels for guaranteed quality and economy.

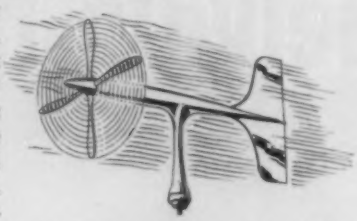
Typical cross section shows the broad V-groove and load equalizing relief groove.

Contact your nearest Albion representative or write direct

ALBION INDUSTRIES, INC.
ALBION, MICHIGAN

WHY DON'T THEY R&D . . ?

The following problems have been encountered by the Armed Forces.



. . . a fast-response anemometer for measuring velocity of surface winds. Ordinary cup-type anemometers do not measure instantaneous velocities in gusty air; inertia of rotating mass prevents fast response. Also, they usually accelerate faster than they decelerate, so measured speed is higher than actual speed. Needed is an anemometer with accelerating and decelerating constant of 3 feet of air. Other requirements: starting speed, 0.5 mph; range, 0 to 100 mph; accuracy, ± 1 mph over entire range; directional accuracy, ±2 degrees. Instrument should require little or no maintenance and be suitable for operation in blowing sand, dust, or snow.

. . . a lightweight, portable power pack. Present commercial batteries produce too little energy for their weight. Most have outputs less than 60 w-hr per lb. Needed is a power source capable of delivering as much power as present chemical cells but weighing no more than half as much. One possibility: higher-energy electrode pairs (see *PE—"Higher-energy Batteries," May 25 '59, p 46*) if a way can be found to store and arrange these reactive chemicals. Another: atomic batteries (see *PE—"Midget Batteries," May 12 '58, p 72*).

. . . a fluid-level indicator for liquid fluorine tanks that have capacities ranging from 200 to 2500 gallons. The direct-reading instrument must indicate level with accuracy of 0.5 in. and respond to changes in level at a rate of 0.5 in. per sec. Output signal should be adaptable to strip recorder or graduated indicating gage.

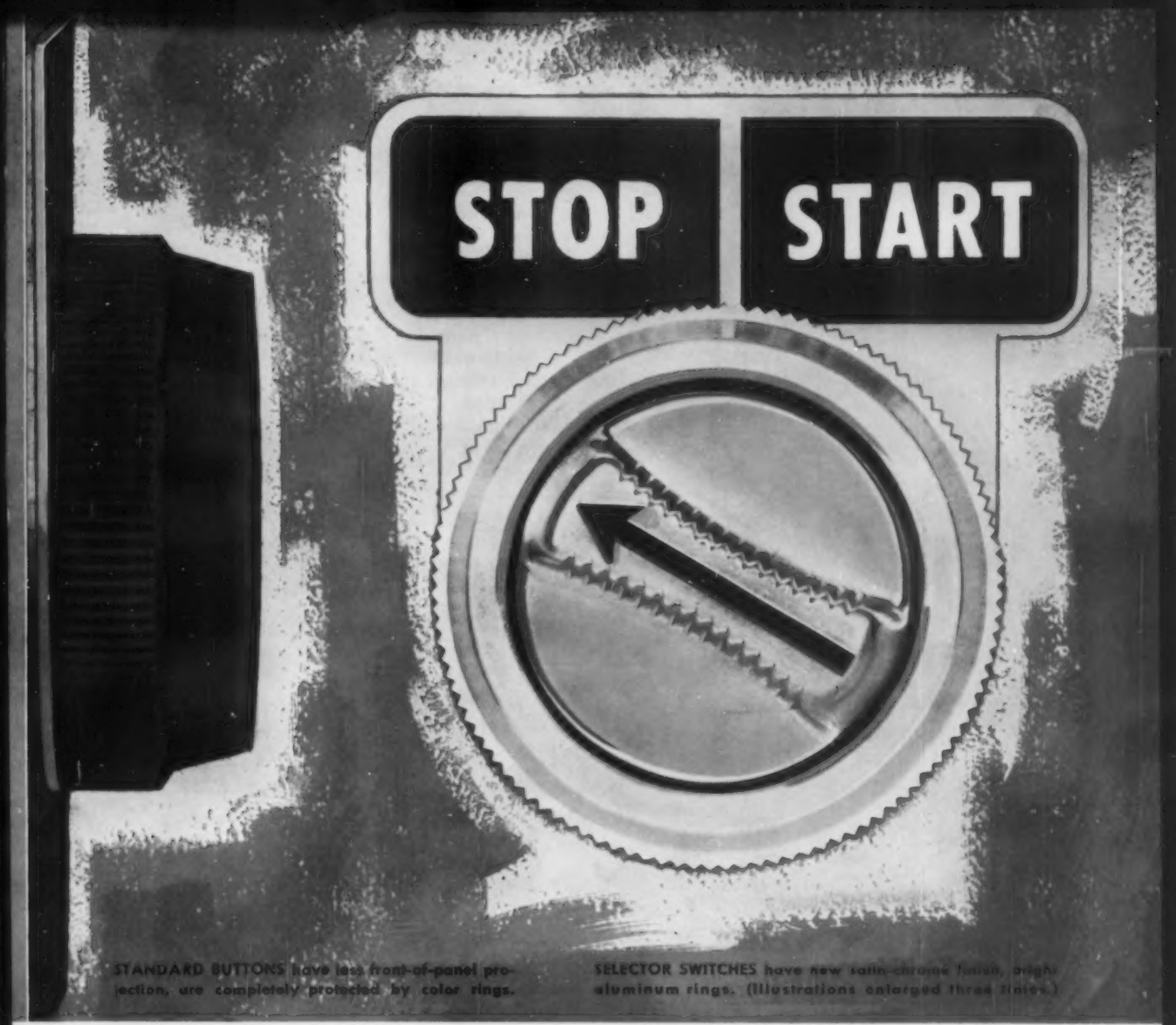
. . . an accurate and rugged instrument for measuring relative humidity. Must give reading with accuracy of ±2.0% over the range from 4 to 100% and be sufficiently rugged to withstand extreme conditions of blowing dust and sand without need for filters that must be changed frequently. Also should have long-term stability and rapid response time (2 to 4 sec). Should not require water or have other features that add weight or detract from its portability.

. . . a collapsible, trailing, aerodynamic decelerator for slowing high-speed airborne vehicles. Decelerator should have large drag area compared with collapsed bulk and weight. Must slow vehicle traveling at hypersonic velocity in low-density air. Other requirements: must have small storage volume when collapsed, be forcibly and reliably deployed, show excellent stability characteristics, and operate at 1800 F without appreciable loss of strength. It is also desirable that it be designed so that drag area can be reduced to 1% of maximum if necessary.

If you think you have a solution for any of these problems—or if you wish additional information—get in touch with National Inventors Council, US Department of Commerce, Washington 25, D.C.

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.

CIRCLE 33 ON READER SERVICE CARD→



STANDARD BUTTONS have less front-of-panel projection, are completely protected by color rings.

SELECTOR SWITCHES have new satin-chrome finish, bright aluminum rings. (Illustrations enlarged three times.)

Three "measurable advantages" of General Electric CR2940 Oil-tight Pushbuttons:

BETTER APPEARANCE, GREATER SAFETY, MORE FLEXIBILITY

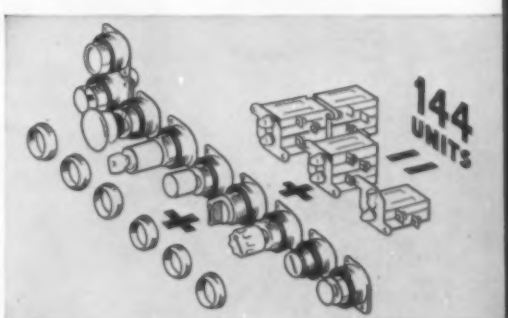
When your machines, consoles or panels include CR2940 General Electric oil-tight pushbuttons, you've built in an extra sales advantage that will improve customer acceptance of your products.

The outstanding appearance of G-E units is the result of several exclusive features: pushbutton color coding is permanently anodized on color rings to prevent loss of identification due to dirt and grime, and to provide positive all-angle color identification; new satin-chrome finish on selector switches and bright aluminum rings resist corrosion and wear, blend well with machines or panels.

The rugged, all-metal standard pushbutton operator hugs the panel to avoid accidental damage. Protected buttons also guard against unintentional operation. Write for bulletin GEA-5779, General Electric Company, Schenectady, New York. 731-20

You get
MEASURABLE ADVANTAGES
WITH GENERAL ELECTRIC CONTROL

GENERAL ELECTRIC



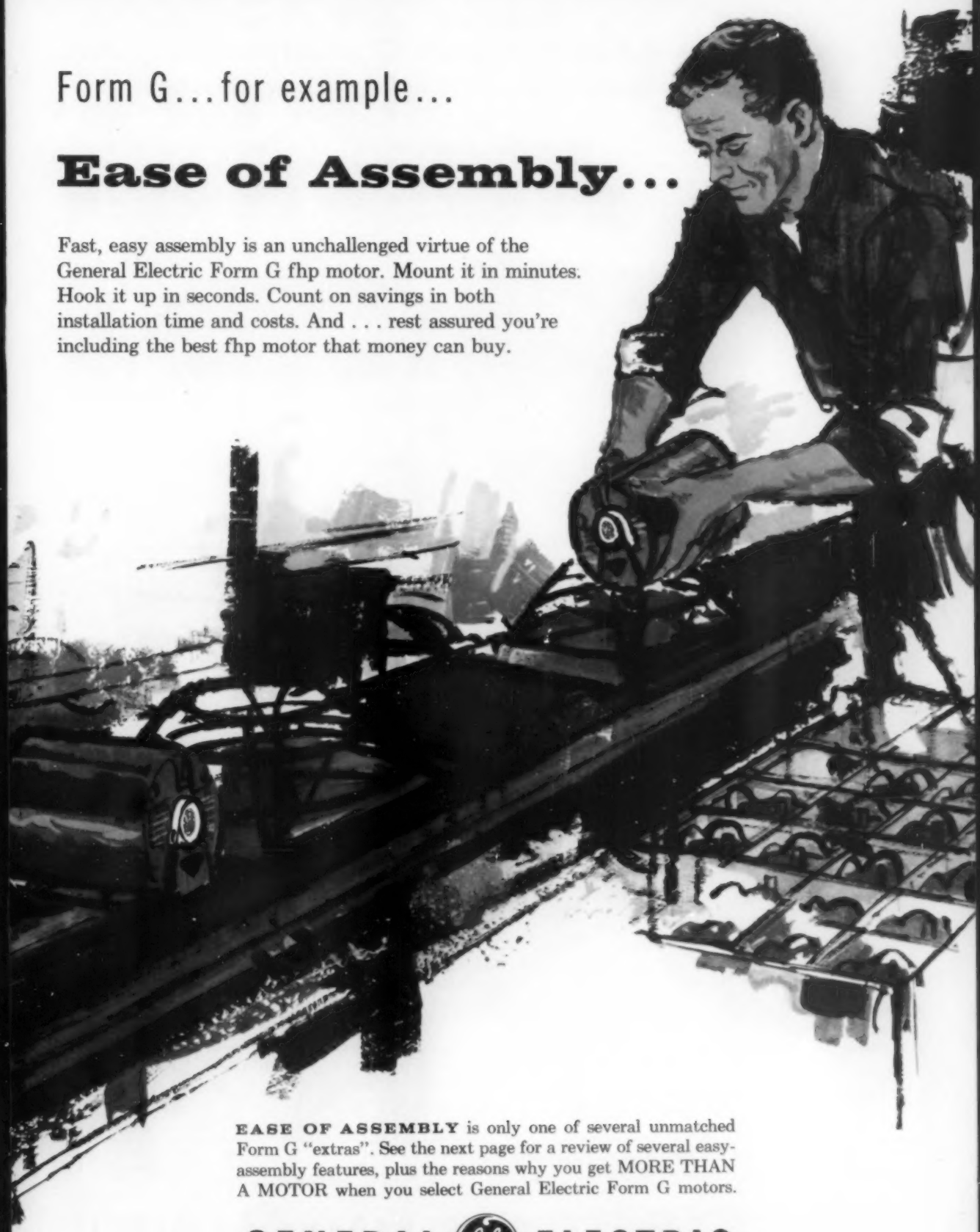
BUILDING BLOCK CONSTRUCTION cuts your stock needs. Just 6 color rings, 8 operators, 3 contact blocks, provide 144 different units. Units can be front- or back-mounted. Variety of separable nameplates adds further versatility.

You get MORE THAN A MOTOR with General Electric's

Form G...for example...

Ease of Assembly...

Fast, easy assembly is an unchallenged virtue of the General Electric Form G fhp motor. Mount it in minutes. Hook it up in seconds. Count on savings in both installation time and costs. And . . . rest assured you're including the best fhp motor that money can buy.



EASE OF ASSEMBLY is only one of several unmatched Form G "extras". See the next page for a review of several easy-assembly features, plus the reasons why you get MORE THAN A MOTOR when you select General Electric Form G motors.

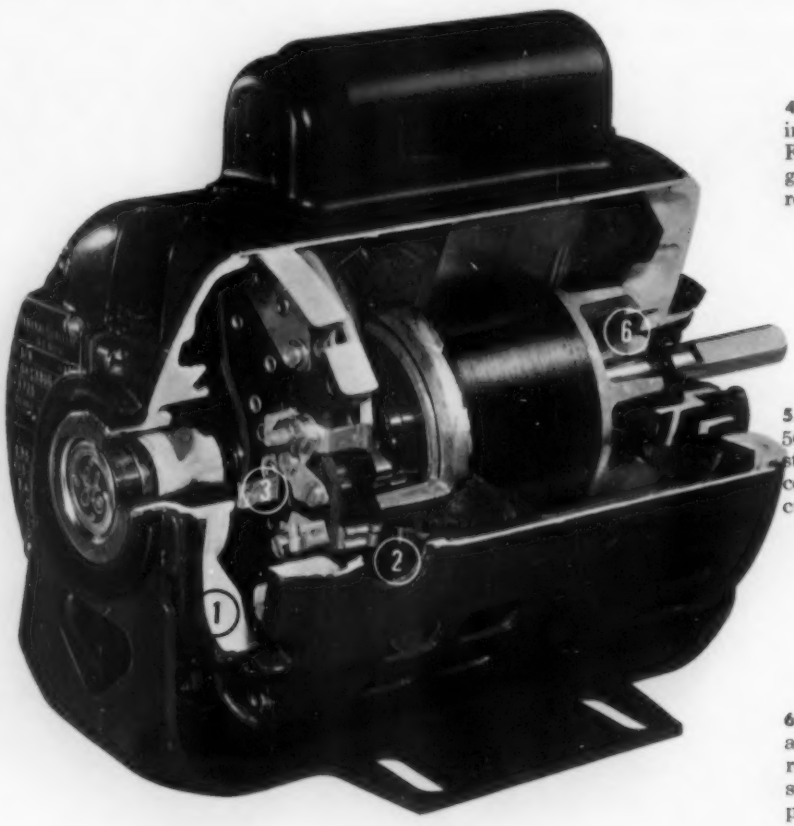
GENERAL ELECTRIC

These years-ahead Form G motor features speed assembly, cut shipping costs

1. EASY TO HOOK UP—An enlarged wiring compartment and a clean terminal board give you greater accessibility; speed connection; save you assembly-line time and money.

2. FAST CONDUIT CONNECTION—A special speed nut, welded inside the motor shell, permits conduit connection from outside; makes hook up fast, easy; simplifies motor installation.

3. FAST LEAD CONNECTION—Quick-connect wiring tabs on all external and internal terminals cut wiring time in half. Simply plug in leads for fast, easy, positive connections.



4. SAFE, SIMPLE GROUND—A built-in grounding lug on General Electric Form G motors permits fast, easy grounding of a third lead (when required) to meet UL standards.

5. COMPACT, LIGHTWEIGHT—Up to 50% lighter, 40% smaller than old-style motor designs, Form G motors cost less to handle, install and ship; cut down assembly-line fatigue.

6. ALL-ANGLE OPERATION—All-angle sleeve bearings and positive oil retention system allow you to mount standard Form G motors in any position. No need for costly specials.

Only General Electric Form Gs give you MORE THAN A MOTOR

1. EASE OF ASSEMBLY—Form G motors provide assembly-line savings in time and money.

2. EXPERT APPLICATION AID—G-E engineers are always available to help solve unusual motor applications.

3. ON-TIME DELIVERY—multi-plant facilities assure you reliable, prompt delivery of the exact motors you need.

4. YEARS-AHEAD DESIGN LEADERSHIP—consistent leadership by G.E. keeps Form G motor customers "out front".

5. VERSATILITY PERSONIFIED—a Form G motor can meet almost any design requirement.

6. FAST, LOCAL SERVICE—a nationwide network of G-E Electric Motor Service Stations means service is always close at hand.

7. QUALITY CONTROL—*every* Form G motor is thoroughly tested at all stages of production to assure you long, dependable performance

Make sure you get MORE THAN A MOTOR when you select fhp drives for your product . . . choose General Electric Form G motors, available in NEMA 48 and 56 frames. For more information contact your nearby General Electric Apparatus Sales Office or write Section 702-111, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

Salt River Valley Water Users Association,
Phoenix, Arizona

Saves $699.00 per pump...

by using ground and polished

fatigue-proof® STEEL BARS **e.t.d.**

made by elevated temperature drawing process

The men who operate the "Salt River" project have the job of supplying water to 240,000 acres of land in Arizona, where the Gila River joins the Salt River. The Association maintains some 250 deep well pumps to help supply the required water.

Richard Juetten, Supervisor of Salt River's Pump Division, reports that the use of La Salle FATIGUE-PROOF steel bars has permitted a saving of $699.00 per pump . . . a potential saving of $174,750 when applied to the 250 pumps now in operation.

Mr. Juetten's report follows:

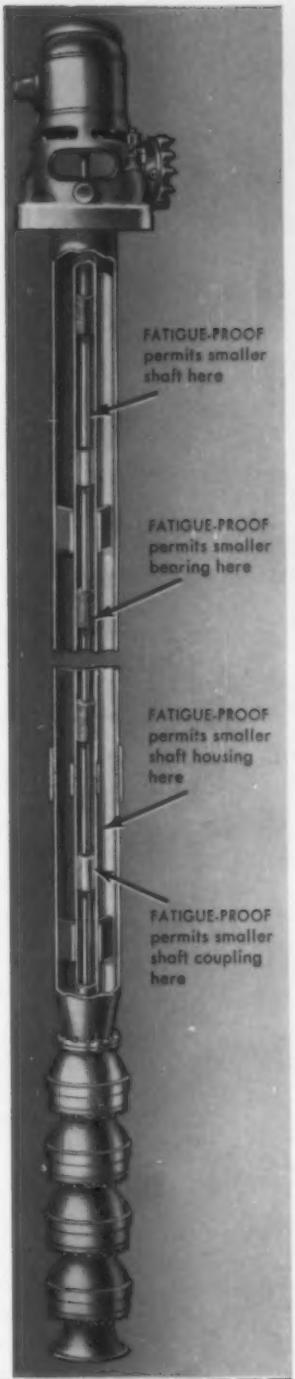
"I have figured our direct saving realized by using La Salle FATIGUE-PROOF steel bars in place of standard C-1045 steel shaft in our deep well turbine pumps.

"FATIGUE-PROOF enables us to use bars only $1\frac{11}{16}$" in diameter . . . instead of $2\frac{3}{16}$" diameter shafts which were necessary when we used C-1045 . . . and this despite higher horsepower, more weight, and additional pump bowl assemblies.

"Here are comparative costs per 10-foot section (of a 300-foot pump shaft):"

using C-1045		using FATIGUE-PROOF	
10' x 2-3/16" dia. shaft	$28.30	10' x 1-11/16" dia. FATIGUE-PROOF	$22.59
3½" shaft housing	26.30	3" shaft housing	19.80
2 bearings, 3½" x 2-3/16"	21.72	2 bearings, 3" x 1-11/16"	13.46
Shaft coupling	5.16	Shaft coupling	2.34
TOTAL cost	$81.48	TOTAL cost	$58.19
Cost per foot	$ 8.15	Cost per foot reduced to	$ 5.82

RESULT: A saving of $2.33 per foot . . . or $699.00 when applied to a 300-foot pump setting. And this doesn't take into consideration reduced power consumption.


FATIGUE-PROOF permits smaller shaft here
FATIGUE-PROOF permits smaller bearing here
FATIGUE-PROOF permits smaller shaft housing here
FATIGUE-PROOF permits smaller shaft coupling here

La Salle STEEL CO.

1430 150th Street
Hammond, Indiana

ASK FOR 24-PAGE BOOKLET—It tells the complete story of FATIGUE-PROOF®

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CIRCLE 36 ON READER SERVICE CARD

CIRCLE 37 ON READER SERVICE CARD 37

HANDY & HARMAN SILVER BRAZING
Permits Manufacturer to Guarantee Underwater Air Regulator For Life

Perhaps the most vital component of a skin diver's equipment, this Viking Air Regulator, manufactured by Christensen Tool & Engineering Company, Norwalk, Connecticut, is structurally guaranteed for life. It must, under all conditions, be absolutely leaktight. The manufacturer's guarantee is a relatively recent achievement—through the high-strength help of silver alloy brazing with Handy & Harman EASY-FLO 45 and HANDY FLUX.

Over and above the unreserved dependability of brazed joints, the brazing method itself has saved the company considerable time, money and material in the production of the Viking Air Regulator. Brazing's simplicity is interestingly illustrated in this case by this company's requirement that assemblers and testers of the Viking must be skin divers themselves.

Almost invariably, silver brazing effects economies and brings advantages to whatever part, product or assembly it is applied. True, air regulators are few and far between, but the point is that they are *metal products, made of a number of different metal components.*

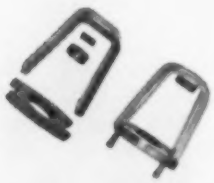
And that's the phrase that covers brazing's great adaptability. To give you a good idea of how you can put brazing to work, we'd like to send you Bulletin 20—it covers the basics of brazing and it may very easily solve your metal-joining problems. Handy & Harman, 82 Fulton Street, New York 38, N. Y.

Here, in "serial" form is how the guarantee is "brazed" into the Viking:

1. TANK HOUSING—Initially, this component was mechanically joined and made "airtight" by means of sealants. Now, brazing eliminates 8 holes, 4 tapping operations, 4 screws and 3 assembly operations.

2. FORK ASSEMBLY—There are five separate brazed joints, done with hand torch and hand-fed wire. Brazing eliminates one tapped hole, a lock washer and a spacer, plus the fact that positive alignment is now guaranteed.

5. Shown here are the finished Viking components before and after assembling. —Brazing by Specialty Brazing Laboratories, Riverside, Connecticut.



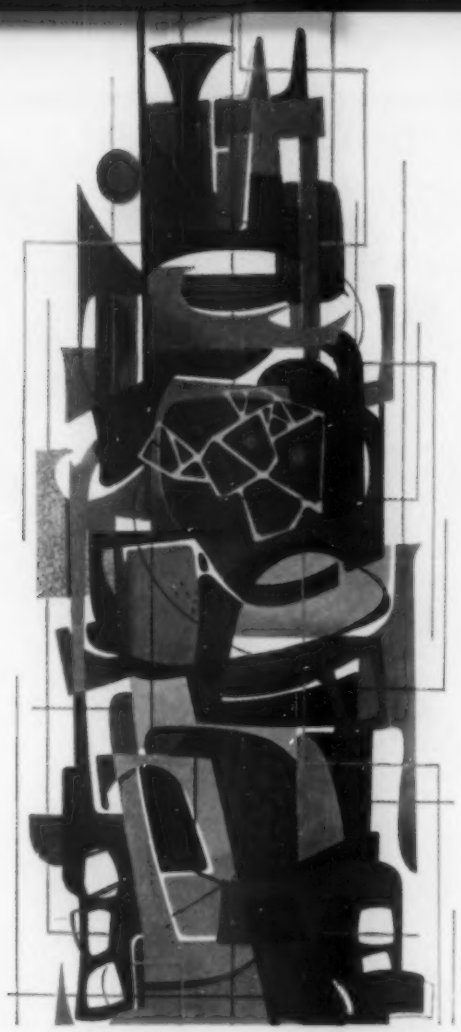
3. YOKE—This is assembled from stampings instead of castings, which were previously used. With brazing, no secondary finishing operations are required. Further, the part is stronger and lighter, and savings on material and labor on this component alone add up to 28%.

4. PISTON—This is the most important single element of the Viking. It regulates flow of oxygen from cylinder to mouthpiece; from 300 lbs. pressure to normal breathing. Without brazing, this part could not be made.

Your No. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN
General Offices: 82 Fulton St., New York 38, N. Y.
DISTRIBUTORS IN PRINCIPAL CITIES

COMING IN NOVEMBER! *New Handy & Harman Brazing Correspondence Course. Simple self-study data on all phases of brazing. Send for details to Dept. BC.*



AS YET WE HAVEN'T SCRATCHED THE SURFACE

Here is material that sets a designer to dreaming . . . **versatile, durable cast aluminum.** Its form is bound only by the dimensions of design. Special finishes . . . including the dramatic beauty of porcelain enamel . . . inspire artistic treatments of surface textures. Here, then, is your opportunity for creating products never before interpreted in cast aluminum . . . opportunity for redesigning new appeal into existing products. Monarch exploratory engineering in new aluminum casting techniques, Monarch facilities for product development and manufacturing can contribute to your sales expansion and product leadership. Write R. A. Lawson, Vice President–Marketing.

MONARCH ALUMINUM MFG. COMPANY

9205 Detroit Avenue • Cleveland 2, Ohio

Manufacturing Achievements in Molten Aluminum.

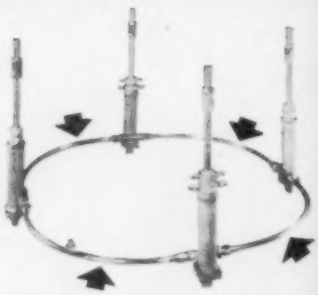
S. S. White

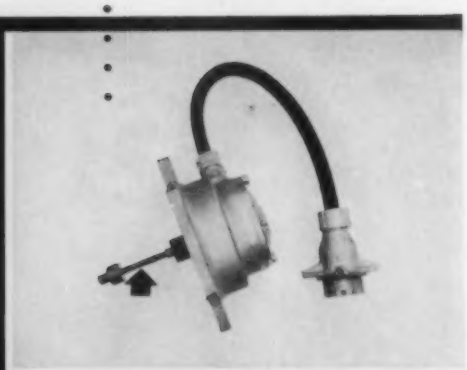
DRIVE AND CONTROL IDEAS FOR ENGINEERS

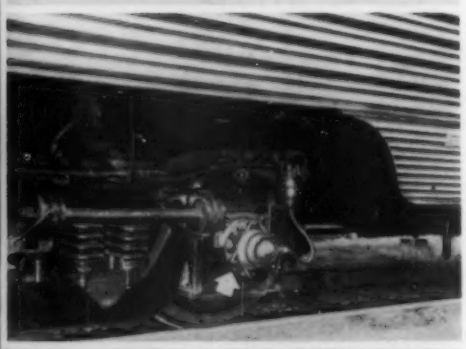
Tips on better designing with flexible shafts

REMOTE CONTROL

Reliable synchronization at high temperature is made possible by S. S. White flexible shafts on this actuator system for jet afterburner nozzles. The job assigned the shafts was to synchronize the system to permit multipoint installation and smooth, even application of power . . . at ambient temperatures up to 650F! To see how flexible shafts simplify design, picture doing this with solid shafts, gearing, universals, and other paraphernalia, around a 360° bend . . . and then imagine installing it!







POWER DRIVE

Running cool at 45,000 rpm! The S. S. White flexible shaft on this grinder-miller permits the use of carbide and diamond tools at speeds that were previously unknown to hand tools. The flexible shaft drives the handpiece from a ¼-hp motor suspended over the table at speeds up 45,000 rpm, without overheating and without vibration. A good point for designers to note is that in many cases, the higher the speed of a flexible shaft, the better the performance.

COUPLING

Alignment and vibration problems are solved by an S. S. White flexible shaft on this railroad brake controller. The device detects wheel slippage during braking, by means of rotary switches on each axle that detect changes in relative movement between pairs of wheels on the truck. If damaging slip occurs, the device releases brake pressure until slippage stops. A flexible shaft is fitted to the axle and drives the rotor in the switch, eliminating alignment problems and preventing excessive axle vibration from reaching the sensitive device.

1056

S. S. White

FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION (Dept. 14)
10 East 40th Street, New York 16, N. Y.

Standard S. S. White flexible shafts are available "off the shelf," making many savings possible. **Write for bulletin 5801.**

USEFUL DATA ON SELECTION and APPLICATION!

S. S. White also offers engineering service and comprehensive selection of flexible shaft sizes and types to meet special requirements. **Write for bulletin 5601.**

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 70

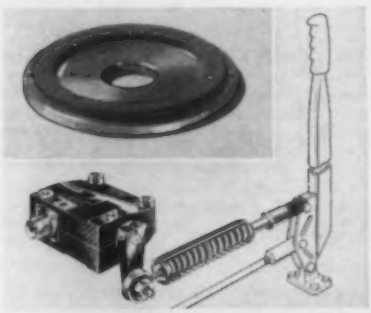
HOW TO ASSURE POSITIVE BRAKING

Problem: Finding a rubbery brake facing that can withstand rugged braking action and high temperatures over extended periods of time.

Solution: Airborne Accessories Corporation, Hillside, N. J., reports excellent results with Silastic®, the Dow Corning silicone rubber. Here's their story:

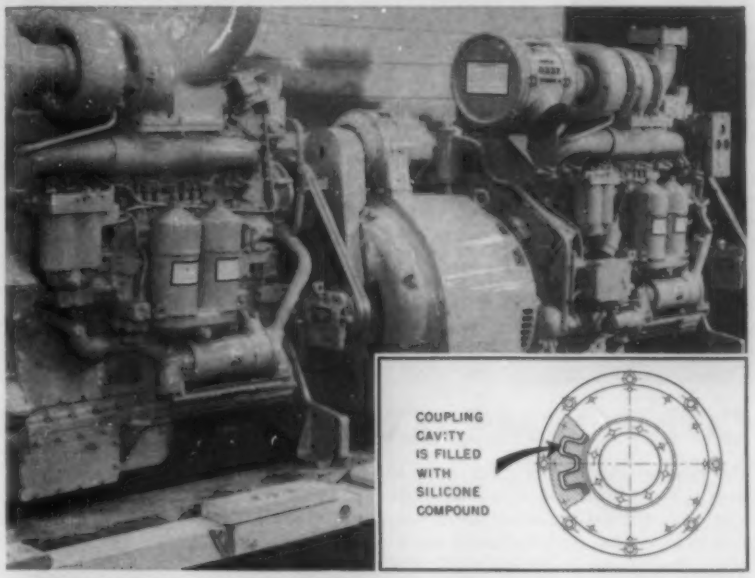
Airborne developed an improved steering control system for rotary wing aircraft. The key unit is a magnetically controlled brake located near the engine that locks the steering controls to relieve the pilot from fatigue. After evaluating various materials, Airborne chose Silastic for the brake facing because its exceptional heat stability, and low compression set characteristics make it the most serviceable and reliable under adverse operating conditions.

The washer-shaped molding of Silastic is 1/16 inch thick and has an outside diameter of 1-13/32 inches. This silicone rubber part enables the braking system to withstand at least 200 inch-pounds of continuous torque at the output shaft (4 inch-pounds at the brake).



Specifications called for a braking surface that would withstand a temperature of 212 F for 48 hours without loss of strength, shape or braking efficiency. Several hundred of these units have been in service for extended periods without a single report of brake facing burnout or other failure.

Because Silastic stays rubbery from —130 to 500 F and is resistant to weathering and many fuels, oils and chemicals, this material is finding growing use for a variety of applications in the aircraft, automotive, and appliance industries. *No. 241*



UNIFORM DAMPING EXTENDS UTILITY

How can you best provide damping in a flexible coupling and reduce the effects of torsionals at critical speeds? Do as the Engine Division of Caterpillar Tractor Co. did: Couple the benefits of a thick rubber cushion with the uniform performance of a greaselike Dow Corning silicone compound.

Caterpillar recently developed a viscous damped, rubber coupling to minimize torsional vibration between engines and any type of loads, or between engines connected in tandem. Heart of the unit is an internal ring gear connected to the engine. This gear meshes with a gear drive spider connected to the load. A thick rubber boot that encloses the internal teeth provides the flexual member.

Caterpillar engineers provided effective damping by filling the ⅛ inch void between rubber boot and drive spider teeth with a Dow Corning silicone compound that maintains a near-constant consistency over a very wide temperature range. Damping from the silicone compound effectively reduces torsional vibration amplitudes caused by torque reversals between load and engine at resonant frequencies.

Dow Corning silicone damping media — both greaselike and fluid — provide uniform damping regardless of temperature, resist oxidation — won't evaporate, thicken or thin-out—and resist breakdown due to shear. In the Caterpillar Coupling, the silicone damping medium helps "preserve" the rubber and give it longer life. *No. 242*

Lubricants that Last

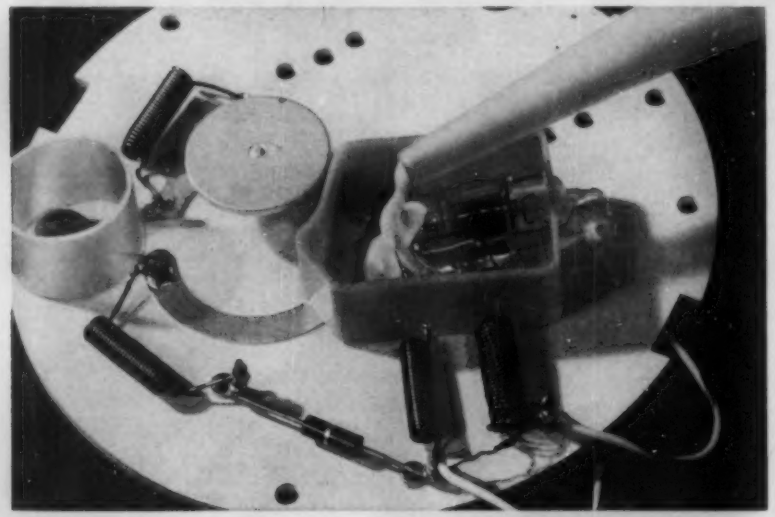
Best way to provide long-lasting, trouble-free lubrication: Specify a nonoxidizing, nongumming silicone lubricant. That's how Appliance Manufacturing Company, Van Buren, Indiana, assures the accuracy and long service life of its timing devices.

Appliance Manufacturing's engineers have found that it pays to use heat-stable Dow Corning 44 Grease on timers that might encounter rough service conditions. A case in point is the timer illustrated below which is used in a popular automatic dryer.

Experience has shown that a minute quantity of Dow Corning 44 Grease applied to this timer's shaft and phenolic cam is all it takes to (1) reduce friction and obtain proper degree of torque in turning the timer dial, *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE
OR REFERENCE NUMBER ON READER SERVICE CARD

MORE



CONFORMS, CUSHIONS, SEALS

Silicones repeatedly enable engineers to design to a fine degree of miniaturization and provide optimum protection against adverse environmental conditions. Such a case is the use of Silastic RTV in the Radio-Sondes manufactured by General Instrument Corporation, Newark, New Jersey.

Radio-Sondes are meteorological instruments linked to integral transmitters. Designed to be launched from aircraft at altitudes up to 60,000 feet and speeds up to 565 knots, these instruments are subject to reduced air pressure and the hazards of arcing and corona due to high potentials involved. At launching, severe slipstream shock and vibration are encountered.

General Instrument engineers specified that vulnerable components of the Radio-Sonde units be encapsulated with Silastic® RTV, the Dow Corning silicone rubber that vulcanizes at room temperature. Silastic RTV flows around intricate parts during application, sets up to a rubbery cushion that puts no stress on delicate parts, and seals out undesirable elements with no degradation of power factor.

Silastic RTV is easily applied with a calking gun into reusable retainer rings, provides the desired physical and dielectric properties. Heat-stable, and flexible in low temperature service, Silastic RTV remains resilient and soaks up shock.

TYPICAL PROPERTIES OF SILASTIC RTV

Temperature range ..... (—70 to 260 C)	—100 to 500 F
Dielectric strength, volts/mil	400
Dielectric constant, 10^6 cycles per second	3.0
Dissipation factor, 10^6 cycles per second	0.004
Moisture absorption after 7 days at room temperature	<1.0%

The preceding table of properties may provide an indication of the practicality of Silastic RTV as an engineering material in your electrical or electronic equipment. For more information, circle . . *No. 243*

LUBRICANTS *(Continued)*

(2) make certain of long service despite moisture and heat and (3) avoid injurious vapors that might poison the silver contacts.

You can count on Dow Corning silicone oils and greases to remain effective long after the best organic lubricants have melted, gummed or oxidized. Job-proved Dow Corning 44 Grease, for example, is serviceable from —40 up to 400 F, provides exceptionally long "shelf life", keeps warranty costs low, and assures quiet operation. *No. 244*

new literature and technical data on silicones

Seal That Valve even under conditions of extreme temperature and contact with acids, alkalies, or steam. Dow Corning Valve Seal retains its uniform consistency . . . keeps pressure-lubricated valves operable. Also lubricates, protects and extends life of most rubber and plastic seals, gaskets and packings. Job-proved in more than 100 different applications listed in this comprehensive data sheet. *No. 245*

You say, they save — You can provide up to 100% longer surface protection if you specify silicone-based paints for the domestic appliances and the industrial equipment you design. Examples of design-customer savings are illustrated in a 4-page brochure. A unique, full page nomograph will help you choose the type of paint best suited for every application, and a separate listing of producers of silicone paints is also included to assist you in obtaining the protective coating you seek. *No. 246*

An Up-to-Date Selection Guide helps you choose the silicone insulating components that make possible electrical equipment with 10 to 100 times longer life. This complete selection table for silicone insulating components and listing of distributors make this brochure an absolute must for every electrical designer's reference files. *No. 247*

How To Make Coils more easily . . . and also get better performance . . . is the subject of a compact 8-page booklet reprinted from NISA News. The use of triangular Guideline Tape facilitates and speeds wrapping — provides the good electrical properties, thermal stability, chemical and moisture resistance characteristic of Silastic®, the Dow Corning silicone rubber. This reprint contains helpful graphs, tables, and illustrations. *No. 248*

You And The Silicones — a new 30-minute, full color movie lets you see silicones in action. It's an all-encompassing, dramatic documentation of designers' adaptations of these versatile engineering materials in different applications. For information about arranging for a free showing, request *No. 249*

Dow Corning Corporation, Dept. 8601, Midland, Michigan

Please send me: 241 242 243 244 245 246 247 248 249

NAME _____

TITLE _____

COMPANY _____

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CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for design and development engineers by

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Dow Corning CORPORATION
MIDLAND, MICHIGAN

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CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

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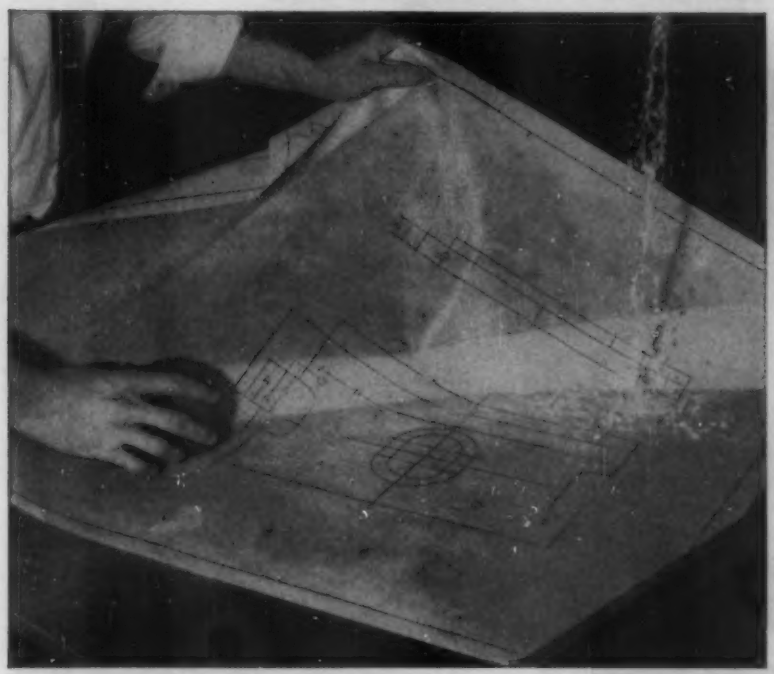
Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.



This badly-soiled drawing is getting a mild soap-and-water bath to restore its original printing quality.

Tracings you can wash! Mention this to a Chief Draftsman and you'd likely see his eyes light up as he perceives the implications of a simple new technique – one that's being used now by Raytheon Co. and could save them at least $50,000 this year. The secret: Herculene® Drafting Film by K&E, plus Staedtler Duralar plastic pencils –a completely washable combination, and the answer to . . .

A Dirty Old Problem

Functionally, an engineering drawing is only as good as the prints it will produce. This is a fact of life that governs any distribution-print system – conventional blueprints, white prints, or reduced-size prints. It holds true in a full-fledged miniaturization program, too. How long will an original tracing continue to produce top-notch prints? The answer depends on how much and what kind of handling it receives. Revisions, smudging, processing and filing all take their toll of a drawing's printability, decreasing it gradually – and sometimes quite sharply. As printing quality diminishes, some form of rehabilitation becomes necessary. But re-drawing – whether manual or photographic – can be costly and time-consuming. Drafting and reproduction experts have been wishing and working for a more efficient and economical solution.

A Simple Solution: Soap-and-Water

Washing became a possible answer with the advent of polyester-base drafting films and plastic pencils – and a practical reality with Herculene. This remarkable film combines a stable, waterproof Mylar® base with a completely washable surface for smudge-proof Duralar pencil lines – which *bond* to the Herculene surface and won't wash off.

Only the dirt washes away. There's no loss of line-background contrast, no loss of detail. The tracing can be restored to its original condition in a few moments – without re-drawing!

A Proved Money-Saver

To amplify an earlier point: the Missile Systems Division of Raytheon has been washing Herculene drawings for the past year, and now expects to save over $50,000 on re-draws alone in the year ahead. A large aircraft manufacturer has used the Herculene-Duralar soap-and-water method even longer, and reports impressive dollar savings plus an outstanding improvement in print quality.

In 6 months of testing and 14 months of actual drafting-room use, Raytheon engineers exposed Herculene to all basic trials – and a battery of fiendishly extreme conditions. They scored Herculene with a sharp scriber, but couldn't remove the matte surface. They taped a sheet to the floor and had a 200 pounder roll over it in a swivel chair during an active day. Herculene was baked and frozen – and doused with hot coffee – with no effect on its surface. After two hours, the coffee stain was washed off without a trace. Results of these torturous tests were so favorable that now, Raytheon's Missile Systems Division uses practically no drafting film *but* Herculene!

A Note of Caution

There are other waterproof drafting films, but plastic pencil lines will wash off some of them. So, when comparing polyester-base films, it's best to check them for *pencil line washability*. And another point – don't try this technique with ink or graphite lines – use only the Duralar K1 or K2. Even if you don't want to adopt the washing technique immediately, you're free to make the change at any time if you use Herculene – the *indestructible* drafting medium with the washable, engineered surface.

More Merciless Testing Invited

We'd be pleased to send you a sample of Herculene, and we invite you to do your best to ruin its excellent drafting and printing quality. The Herculene sheet comes in a small folder with complete instructions and a water-fast Duralar pencil – which K&E engineers helped develop for use with washable Herculene Drafting Film. Mail the coupon below for your sample!

KEUFFEL & ESSER CO., Dept. PE-1, Hoboken, N. J.

Please send me further information about the washable tracing method, plus a sample sheet of Herculene Drafting Film and a Duralar pencil.

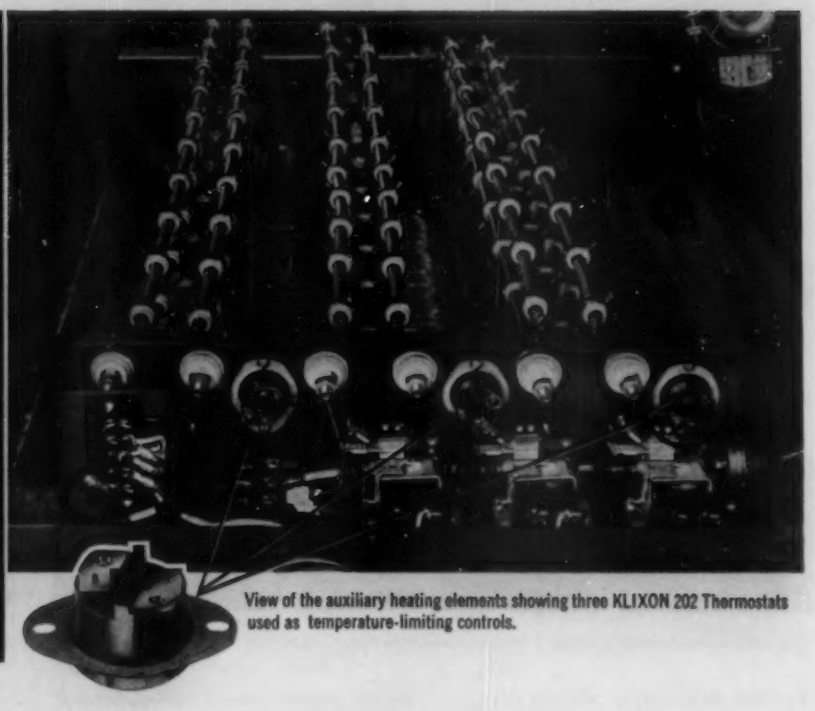
Name & Title_____

Company & Address_____

_____ 1509

YOU CAN BE SURE... IF IT'S Westinghouse

Cutaway of the indoor section of the Westinghouse Heat Pump.



View of the auxiliary heating elements showing three KLIXON 202 Thermostats used as temperature-limiting controls.

...And Westinghouse Counts On

KLIXON *Snap-Acting* THERMOSTATS

For Trouble-Free Performance in Their Remote Heat Pump

Cooling in hot weather, heating when it's cold — complete year-round comfort — and it is all done automatically with one modern Westinghouse Heat Pump.

To insure accurate, trouble-free operation of their heat pump, Westinghouse uses *five* KLIXON Snap-Acting Thermostats in each unit. Three are used as temperature-limiting controls on the auxiliary electric heating elements. Another is on the discharge line of the compressor to limit discharge temperature. A fifth KLIXON Thermostat controls a small heater element which regulates compressor oil temperatures to prevent the refrigerant from condensing during shutdown.

Here's what Mr. G. L. Biehn, Air Conditioning Division, says about KLIXON Thermostats:

"Their performance and dependability are evidenced by the fact that this division has used them in various pieces of our equipment for many years."

Westinghouse — another leading manufacturer who specifies and uses KLIXON Controls. Available in both sealed and open construction, these controls are made in a wide variety of types and sizes. Fixed temperature settings are custom calibrated at the factory to meet specific application requirements.

Send details on your control needs, and let us acquaint you with the application possibilities of the KLIXON line. Also, inquire about engineering assistance at no obligation. Write:

METALS & CONTROLS

3801 NORTH MAIN ST., VERSAILLES, KENTUCKY

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

SPENCER PRODUCTS: Commercial Controls Department

PRODUCT ENGINEERING HORIZONS

January 25, 1960

IS YOUR STATUS SHOWING?

Best of current status symbols is supposed to be a copy of Vance Packard's "The Status Seekers" lying on your library table—or on the living-room table if your house doesn't have a library. It establishes your superiority to status, thus gives you status as a modern intellectual.

Here is a paradox! In a country founded on equality, we are more conscious of status than they are in countries where rank and social position are accepted. We have no aristocracy, no "400" even anymore—so we substitute money, houses, cars, trips, guitar-playing friends. Since Oct 4, 1957, we've been kowtowing to learning as well.

Now, everyone knows that status exists among even the lowest orders of animals: The hens in a barnyard have their "pecking order," horses and cows choose a leader, savages dress one man in feathers or an old derby and call him chief. We superior beings laugh—but we kowtow to the office holder with a shield on his car, the man with ancestors or a moldy title, the member of the "right" club, the bon vivant who knows a head waiter or can order the right wine, the current TV or movie favorite.

Intellectuals profess to be above status symbols, but they too adopt ways of speaking, drop names, create exclusive groups, hold exclusive meetings. So do the professions, the crafts, the neighborhoods, the graduates of particular colleges. The beatnik surpasses them all by herding together to make the absence of anything significant a status symbol.

It seems rather obvious that status symbols and status are instinctive among all of us. We even use the words "symbol" and "image" to express aspirations. We buy products because they are "distinctive" or "unusual," or because the maker has a "name." We decorate our prize possessions, our churches, our finest buildings, to show they have status. We decorate our homes, mow and shrub our lawns, hang art in our houses for the same reasons. What's more, we find it irritating and wrong for a deacon to dress as a bishop, for a private to wear a general's "scrambled eggs," for an elevator operator to dress as soberly as a banker—even more irritating for any of the status holders to reverse the procedure and "dress down."

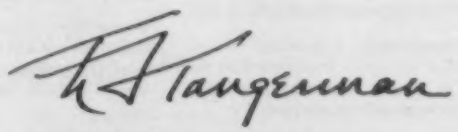
All of us hailed Detroit's decision to upgrade the cheaper cars—until suddenly all cars were big and showy and there was no status left. Now the pace setters have turned to boats and foreign cars and trips abroad to establish their singularity.

We engineers have our status symbols, too. We tend to worship at the shrine of certain words and phrases: automation, numerical control, parameters, brainstorming, creativity, reliability, space technology, magnetohydrodynamics. (These will do for current examples; they'll be different in a year or two anyway.)

To the engineer, this instinct for status is important in two extra ways. It affects his desire for professional recognition, which is status seeking too. The license didn't do it, the professional society didn't do it, and Sputnik I, which might have done it somehow enhanced the status of the scientist instead. We have been shouting "Me too!" which is never as strong; it might be better to let the word get out that a surprisingly high percentage of business executives have engineering backgrounds, that engineering is making our mechanized world possible.

The second application of the status instinct is in the evaluation of a new product. Is it for the masses or for the classes? Should the design be aimed at exclusiveness or at economy? Should it be austere or chromed, have a low, expensive hum or a loud roar? Should it be a "sensation," or should it win acceptance quietly?

And what of its designer or designers? Should he or they be anonymous, or featured? What should the public image be? Can—and should—we make sure our status is showing?



In steak or plating, thickness counts. A good thick layer of Nickel under the chrome will give your product a finish that not only *looks* like quality but also *keeps* that look despite hard use.

Brushed Nickel-Chrome...an enduring finish that gives a quality look at a practical cost

Look at the door of this built-in oven ... at the top of the drop-in range.

The rich beauty you see is brushed Nickel-Chrome Plating.

You may have heard of this finish as "brushed chrome" or "satin chrome." By any of these names, brushed Nickel-Chrome Plating offers you a way to dress up your products at little — if any — increase in production cost!
Here are five big reasons why:

Quality Appearance. A brushed Nickel-Chrome finish tells your customer that the article he is buying is of high quality — inside as well as on the surface.

Durability. This finish keeps on saying "quality" despite hard use. One or even two punishment-taking layers of Nickel, flash-coated with chrome, resist nicking, scratching, wearing, and corrosion. What's more, this finish resists staining, is easy to clean.

Easy to Fabricate. Brushed Nickel-Chrome can be ... is being applied to all the easy-to-fabricate metals — steel, zinc, aluminum, copper, brass — to take advantage of the physical and mechanical properties of these metals. Less common metals can also be readily plated.

Versatility. Brushed Nickel-Chrome has many unique advantages. For example, by selective buffing, you can get bright trim effects without using trim hardware.

Practical Cost. Experience of manufacturers already using brushed Nickel-Chrome shows that this eye-catching finish costs only a few pennies more than ordinary finishes.

With Nickel in ample supply as far into the future as any man can see, you can take advantage of brushed Nickel-Chrome Plating to give your products extra sales appeal. For more ideas, write for our booklet, "Practical Answers to 40 Practical Questions about Nickel Plating."

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO Inco Nickel... *makes plating perform better longer*

how to measure and improve

ENGINEER EFFECTIVENESS

EUGENE O KLIMT, *senior design engineer*
McDonnell Aircraft Corp
St Louis, Mo

Can we get more engineering per engineer? Harry H. Goode, technical director, Systems Div, Bendix Aviation Corp, asked this question in the Sep 21 issue of PRODUCT ENGINEERING. He suggested that operations research, electronic computers and the like can extend the engineer's reach well beyond today's limits in problem areas never before approachable.

But what about the tasks and challenges of ordinary day-to-day engineering? Are highly trained and experienced men wasted in low-level or peripheral nonengineering work? Our author says yes—and proves it with his own survey.

Here's a method of measuring engineering effectiveness—and a program for improvement in your own company.

By effectiveness I mean a combination of two factors. One matches engineer capability with the capability level needed by a particular project; the other measures percent of available time actually spent on the project.

For example, the engineer who spends all his time on a project needing only half his capability is only 50% effective. He could double his contribution if the project demanded it (Fig 1).

If an engineer's capability is strained to the utmost on a particular project, but only for 50% of his time, he is also only 50% effective because he could double his output by working 100% of his time on the project.

These two factors can be combined in a single formula:

$$E = \frac{t}{T} \times \frac{D}{C} \times 100$$

where E is engineer effectiveness in percent; t is time actually spent on the job by the engineer; T is time required to do a job at its rated difficulty level; D is the difficulty level of the job; C is the maximum capability level of the engineer.

Note that T (time required) can never be less than t (time spent), and D (job difficulty) cannot exceed C (engineer capability).

The two ratios can be so plotted that effectiveness appears as a family of hyperbolas, Fig 2.

Note that personal factors such as fatigue and work breaks are necessarily involved in the normal functioning of a job but these can be assumed to be already included in time-required and time-spent estimates as unvarying factors.

Efficiency is the way one does a job, in comparison with the best way to do the job. A man may be overtalented for a given job and do it very well, hence the job may be done efficiently, but the engineer need not work efficiently.

The Evidence

Are engineers wasted? It is clear that they think they are—else why are the personnel ads offering job challenge

and opportunity as the most enticing lure:

Disenchanted engineers . . . if your employer has failed to utilize your full potential . . .

make an important contribution to your nation's progress . . .

our environment stimulates professional creativity . . .

exciting opportunities . . .

technological challenge . . .

need elbow room?

challenging opportunities . . .

cut off from creativity?

And so they go. I've confirmed the convictions of ad writers with a little survey of my own: 38 engineers were asked to fill out a short questionnaire; 27 responded. Only graduate engineers employed in different capacities and in different companies were queried.

The Industries were

Aircraft—1 (company)
Chemical—2
Construction—2
Electrical/electronic—2
Public Utility—1

General level of position was divided among

Junior engineer—1
Senior engineer—16
Supervisory engineer—10

Those listed as senior and supervisory engineers were between 30 and 45 years old, and had professional engineering experience of from 5 to 15 years.

Each man was asked to estimate what portion of his working time was spent in work

1—above his capability
2—equal to his capability
3—below his capability but requiring a degree
4—within range of any alert highschool graduate
5—mechanical motion—no mental exercise required

Averages are shown in Fig 3. Of the group the junior engineer estimates 88% of his time spent in category 4, 11% in category 3, and only 1% in category 2 (equal to capability). He is either a grossly wasted or extremely egotistical young man.

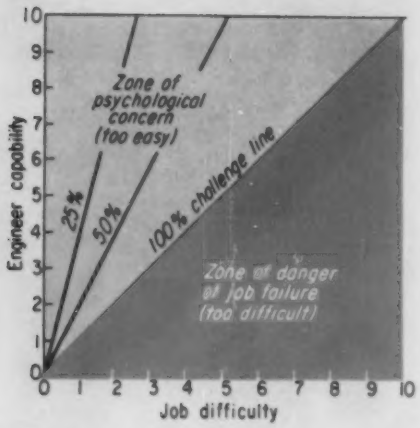
The significant conclusion to be drawn from this survey is that the engineers are fully effective less than half the time (44%) and use their engineering training only 70% of the time. Even adding the 9% wasted time for work breaks and the like, the current level of engineering effectiveness could be increased from 79% to 100% at the modest cost of one-fifth, perhaps a little more, of a highschool graduate's salary.

The Causes

Why are engineers so poorly used? Is this characteristic unique with engineers or do all highly trained executive-level men waste a good percentage of their time? Some wasteful practices are unique to engineering; others are more general, but equally costly.

Hoarding is outright and wholesale waste. Its purpose is insurance and as such is often a justified expense. Workload fluctuates as contracts are signed or completed. New work can't always start on schedule if old projects are delayed, and engineering projects are often delayed.

Balancing of skills, time and numbers of people; the relative cost of hiring and training new men; the effect of a hire-fire routine on the company's reputation; customer's insistance that a staff of engineers be "ready to go" before a contract is signed—all these are factors to be balanced by management. But, right or wrong, a hoarded engineer is a wasted engineer. He knows it and it will affect his later work as well.



1 **CHALLENGE** is the ratio of engineer capability to job difficulty. Ideally an engineer is kept on the 100% challenge line. The upper left area is morally disintegrating and may cost you a good man. The lower right area jeopardizes the entire project. Given enough time an engineer can, and probably should be required to stretch himself to perform work above his present level of capability.

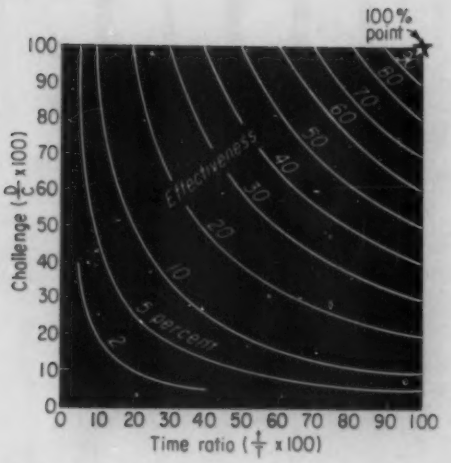
Duplication of effort within an industry or even within a single company is often excused by the argument of "healthy competition." Competitive effort is probably justified if the aim is to save time, improve efficiency, or have a back-up program to raise the probability of success. Dual projects for weapons systems may be justified on this basis.

But duplication is expensive. It may be justifiable for life-and-death projects, but marketplace economics ordinarily won't permit it. If you know about it, cut it down where you can. If you don't know of any in your company take another look around—you've got a communication problem.

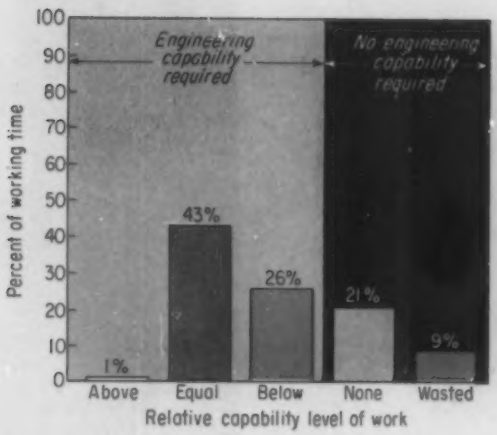
There are gray areas where an engineer's work ends and someone else's begins. For example: administration, buying and selling, cataloging and filing, computing, drafting, field engineering, inspecting, secretarial, specification writing, expediting and liaison, technician work. For the sake of continuity of thought or occasional urgency, an engineer can and should continue into these nonengineering areas. It depends on how long it would take to explain the task.

But everyday misapplication of trained talent to secretarial work or low-level boardwork is the engineer's most consistent complaint. Competent stenographic personnel are rare, especially those trained to record scientific and mathematical data. Typing pools trained and set up for engineering departments can work well—the only complaint is the longer time required for processing.

Companies are slowly becoming aware of what this costs and a few hesitant attempts at correction have



2 **EFFECTIVENESS** establishes the compatibility of job and man combined with the relative use of available time. Note that while job difficulty (D) may at times exceed a man's capability (C), he theoretically cannot accomplish the job on the short run. He can extend his capability by using more time and eventually complete the job, but this changes the initial condition.



3 **ENGINEERS ARE CONVINCED** that most of their time is spent on tasks well below their capability. These are averages of 27 graduates' opinions. While there was no great uniformity in response, the survey indicated considerable engineering time is wasted on nonengineering tasks.

been made. One of the surveyed companies has two dictating machines "available to the engineers"—to approximately 500 engineers—and the two machines are stationed in the manager's office. Another has provided an average of one secretary to every 50 engineers.

It is only fair to add, however, that most engineers are well satisfied with the physical facilities provided—offices, laboratories, and equipment appear to be amply and readily available.

Not unique to engineering, but equally important, are: adequate communication, defined responsibility, delegated authority, planned goals, defined problems, clear-cut decisions, schedules, and the like. Such areas need attention in all organizations, but it is curious how often and how serious they are in the engineering field. Engineers seem to complain more about management than do others. Probably they are more sensitive to controls and the engineering mind is not as adept with managerial (that is, personality) problems, or as tolerant. To make matters worse, the top-level engineers actually in control may have reached their position because of technical proficiency rather than managerial ability.

Relinquishing technical duties means giving up the primary interest and the full exercise of talent to many rising engineers. They are reluctant to put away their slide rules. But the acceptance of a managerial job requires acceptance of the function. The manager who spends too much time in detail robs his entire staff of responsibility and job satisfaction.

The idea of putting a nontechnical man in charge has the merit of avoiding this problem—though it adds the possibility of misunderstanding and friction between the two different kinds of men.

Engineers should be selected for supervisory positions on the basis of both talents—engineering and supervision. Most companies provide lectures and other training aids for new supervisors, but this is really too late. A man should be a good supervisor before he is offered a position; he cannot wait until appointment and then learn the job.

Type casting is as much a problem among engineers as it is among actors. Engineers are assigned to one specialty so often they lose the background and versatility for other work. This dries up the source of replacement talents. There is justification for assigning a man to a job, even when another can do it better, just for the teaching and broadening effect it will have.

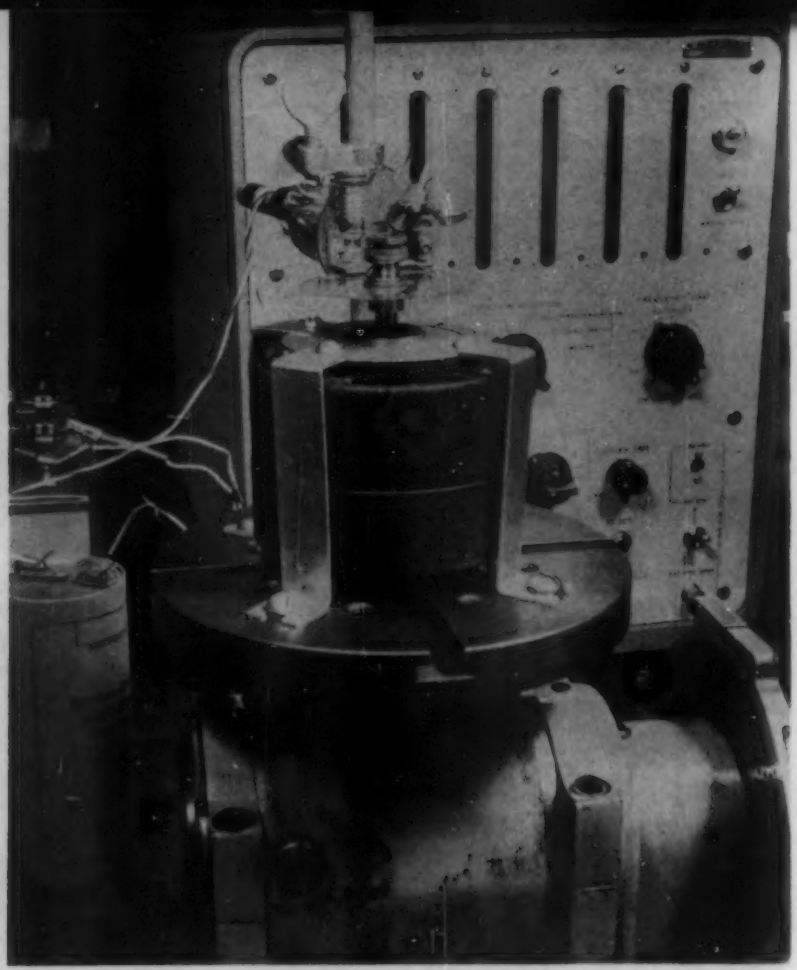
Similarly, younger engineers must often be assigned tasks beyond their capability, though not at the expense of the project or personalities.

Inadequate job definitions are all too common. Titles, duties and responsibilities are left hanging in air until after the job is completed. The dynamic company with rapidly changing assignments makes job definitions difficult sometimes, but a man has to know what is expected of him. Occasionally managers solve this problem by telling a man he's "in charge" of a job only to repeat the same assignment to one or more others on the same or overlapping jobs. There are few more irritating practices.

Standardization can make a mechanical task of many complex engineering problems. Charts, manuals, tables, graphs, formats, and formalized methods and procedures are invaluable time and error-savers. The American Standards Association, the many government specifications and the various technical societies can substitute for a good percentage of a company's high-priced engineering time.

Summing Up

Increased engineering effectiveness is simple and it is more rewarding than artificially stimulating highschool youths to try for engineering degrees. A lot of benefit would result from a bit of self-appraisal and housecleaning; and engineers should be better at this than most. ■



six methods for measuring

CYCLIC SPEED VARIATIONS

Average speed is readily measured, but cyclic variations repeated in each revolution require measuring methods based on microsecond time intervals. Of these six methods, author's slit-type optical tachometer offers highest accuracy—with relative simplicity.

R R ANDERSON *Bell Telephone Laboratories*
Murray Hill, NJ

A drive rotating at what seems to be constant speed may actually have almost undetectable fluctuations within each revolution. These fluctuations, sometimes called jitter or flutter, are often the cause of hard-to-analyze problems such as gear chatter, shaft vibrations, and low fidelity of tape recorders.

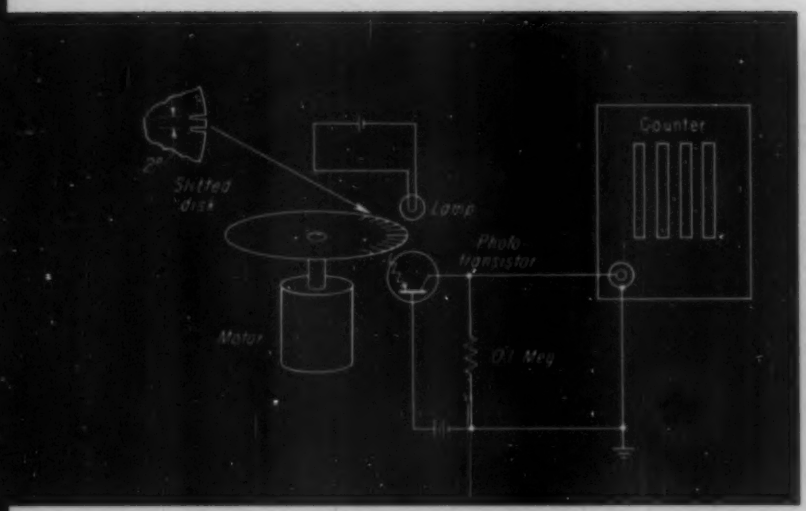
Measuring these speed variations is a ticklish problem because detection of almost instantaneous speeds requires accurate measurement of elapsed time for a specified fraction of a revolution. Bell Laboratories, in its attempt to improve performance of tape recorders, analyzed a number of methods that appeared to be applicable. For purpose of this discussion these methods are grouped as follows:

1. Tachometers
2. Stroboscope
3. Lissajous pattern
4. Flutter meters
5. High-speed photography
6. Slit-type optical tachometer

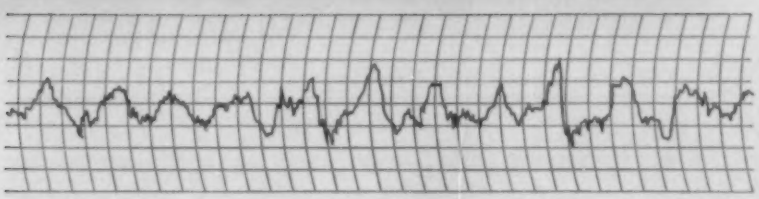
It is felt that the slit-type optical tachometer is the most accurate.

1 Tachometers

They cover a wide range of methods. Speed can be measured by a simple, manually operated revolution counter and stop watch—or by a complex electronic chro-



SLIT-TYPE OPTICAL TACHOMETER applied to a tape recorder motor counts the time for 2° rotation of shaft; turntable rotates stator in 5° steps to obtain speed at 72 points.



FLUTTER METER RECORD at chart speed of 5 in./sec for a 1000-cps tape signal at 3.75 in./sec on a tape recorder. Major wave responds to eccentricity in driving spindle; minor wave shown cyclic speed variations.

nometer. The more common types are:

Centrifugal tachometer–fly ball or fluid type.

Drag cup with indicator needle–such as speedometers.

Electric tachometer generator and voltmeter–ac or dc.

Tachometers are generally used to measure speed, not variations in speed. To give the speed exactly, the measuring instrument must average over a relatively long time interval. It is inherently inaccurate when measuring for short periods, and is therefore unable to measure jitter. Consequently, none of the tachometer types mentioned above is adequate for the purpose.

2 Stroboscope

The stroboscopic effect gives what is essentially a frequency-comparison method for measuring speed. The rotating part appears to stand still if seen once per revolution for a very short time at the same part of each cycle. This effect is ordinarily produced by a flashing lamp, the flashing frequency of which is known. If the rotating part is illuminated at a uniform rate exactly once per cycle of its average frequency, any variation from this average causes a visible jitter. For additional resolution the cycle can be subdivided. A stroboscope disk illuminated by a number of flashes per revolution will display jitter for a fraction of a revolution whenever there is any variation in speed. However, accurate measurements are difficult, even with slowly varying speeds–high-frequency jitter merely blurs the edges of the stroboscopic pattern. In fact, such blurs will always be present because of the finite flash duration.

3 Lissajous Pattern

In this electrical method an oscilloscope is used to match an unknown with a known frequency. But disadvantages of the stroboscope apply here too. High-speed jitter merely deforms the ellipse (Lissajous pattern) that appears on the oscilloscope. Even qualitative results are difficult to obtain.

4 Flutter Meters

A flutter meter takes random signals and filters out selected frequencies. The usual range for a filter is 500 cycles, and frequencies above and below its range are not indicated. The output of a flutter meter is usually fed to a chart recorder to produce an oscillogram such as the one shown here recording flutter for a tape recorder.

Analysis of such a record is difficult; even at maximum chart speeds the cyclic variations are indistinct. Primary value of the record is for rapid over-all evaluation.

An analogous mechanical device, called the Torsio-

METHODS FOR MEASURING CYCLIC SPEED VARIATION

METHOD	EFFECT OF MEASURING SYSTEM	ACCURACY	AVAILABILITY (OR COST)	EASE OF USE	TYPICAL APPLICATIONS
Slit-type Optical Tachometer	low	very high	Electronic counter needed; setup is custom-built; cost, moderate	Little setup time needed; minimum adaption to tested part	Tape recorders and instrument drives
High-speed Photography	none	high	High-speed cameras and film processing needed; cost, medium to high	Complex and time-consuming	Solenoid armatures and high-speed vibration
Flutter Meters	none	medium	Commercial meters are of moderate cost	Easy to use if recorded signal is available; analysis not simple	Tape recorders and machinery drives
Stroboscope	none	low	Commercial units are of moderate cost	Simple to use; results are visual	Textile machinery and newspaper presses
Lissajous Pattern	generally high	low	Oscilloscope is needed; balance is custom-built, cost is low	Requires sine-curve gear to be added to part being tested	Same as stroboscope where recording is needed
Tachometer	medium to high	very low	Cost is low to high, depending on type	Simple to complex	Simple units used for various machinery; electronic units used for high-speed rpm and frequencies

graph, can test any rotating machinery without need for recording tape. A light aluminum pulley is coupled by means of a light spring to a high-inertia flywheel which rotates at average speed of the mechanism. A recording pen is so connected to the pulley and flywheel that the pen movement is proportional to angular displacement between pulley and flywheel. This device was designed to record gear chatter; the pulley is light enough to follow this type of variation. It would also be useful on tape recorders, but has no advantage over the flutter meter.

5 Photographic Methods

High-speed photography can accurately measure rapid motions. The usual procedure is: photograph the motion at proper frequency; determine time interval between frames; correlate the derived time and displacement data in graphical or tabular form. The film speed must be a few hundred times the surface speed of the rotating part being tested. Available high-speed cameras are capable of 10,000 frames per second, which offers adequate resolution for many applications. By projection, time can be measured to a ½% accuracy and displacement to approximately 0.2 mils (0.0002 in.) divided by the magnification of the camera optical system. Principal disadvantage of such photography is the tedium involved in making detailed measurements on frame after frame.

Photography can also be used in combination with an oscillogram. In fact, there are many ways of using an oscilloscope for measurement of speed variations. However, accurate measurements are made more easily in other ways.

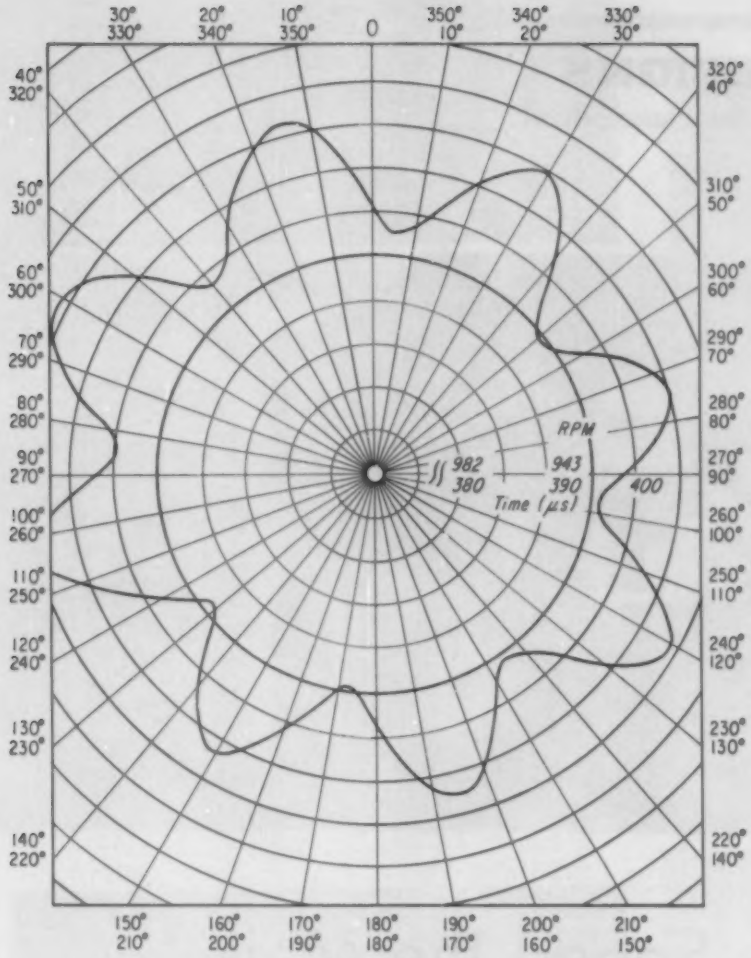
6 Slit-type Optical Tachometer

Optical tachometers are commercially available. They operate by energizing a photocell with light reflected from the rotating part. The surface of the rotating part is made alternately reflecting and nonreflecting. However, in these optical tachometers the arrangement of the light beam, the requirements on the photocell, and the poor signal-to-noise ratio seriously limit their accuracy.

To overcome this limitation the slit-type optical tachometer was developed. While initially used to measure speed variation in a motor of a magnetic tape recorder, this instrument is applicable whenever sensitive measurement of cyclic speed variation is needed. Some advantages: 1) relative ease in setting up test apparatus; 2) accuracy. It consists of:

1. Slitted disk of very light material attached to the shaft being measured.
2. Light beam.
3. Photo transistor.
4. Electronic counter.

The disk is cut with 180 radial slits, 2° apart. They interrupt the light beam giving 180 pulses per revolution. By blocking all but two adjacent slits this device gives two pulses separated by exactly the time required for the shaft to rotate 2°. This time interval is measured with an electronic counter. By measuring on different pairs of slits



POLAR DIAGRAM OF CYCLIC SPEED charts the time for 2° shaft rotation for each 5° rotation of tape recorder motor. To show cyclic variations more clearly, center of chart is expanded. Center is 370 microseconds, corresponding to 980 rpm. Peak variations match the number of poles, giving flutter at eight times synchronous speed. Diagram is off center, giving flutter at synchronous speed.

it is possible to find the speed variation throughout the complete revolution. The same result can be obtained by mounting the motor on a turntable and rotating the stator several degrees between measurements. (In the test setup shown, the motor was rotated 5° between measurements.) The readings taken from the electronic counter are then plotted on a polar diagram.

This diagram shows the time to travel 2° at various angular settings of the stator. The upper scale shows the equivalent motor rpm, if the instantaneous speed were maintained for the entire revolution. For a 900-rpm motor, the average time to travel 2° is given by:

$$\frac{1}{900} \times \frac{2}{360} \times 60 \times 10^6 = 373.4 \text{ microseconds}$$

The slit-type optical tachometer is the most sensitive device tried for the measurement of rapid speed variations, and it comes closest to measuring instantaneous speed. Considering both displacement and time errors, the obtainable accuracy is within 1% of the plotted measurements. Displacement errors are minimized by using the same pair of slits and rotating the motor stator for different readings. The minimum interval between slits is limited only by the speed response of the photo transistor. This, in turn, determines the minimum slit spacing.

The slit-type optical tachometer can be used on practically any rotating part, and a similar arrangement could be used to measure accelerating linear motion—provided a device for interrupting the light beam can be mounted.

The accompanying table compares the five other methods with the slit-type optical tachometer.

EDITOR'S NOTE: For additional information on speed-measuring devices see:

Analysis of Oscillatory Motion Using High-speed Photography, June '56, p 135. Detailed description of photographic methods; also gives derivation of expected timing and measuring accuracy, required film speed, and illustrative studies of a vibrating spring and motion of a solenoid.

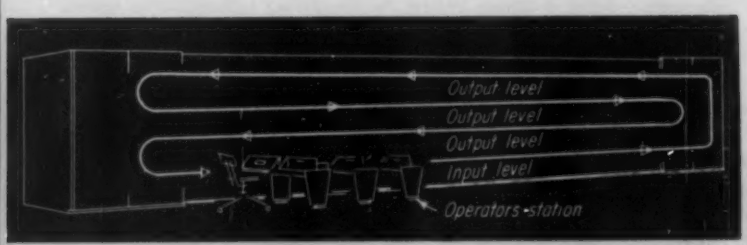
High-speed Photography in Design, Sep, '52, p 167. Basic considerations are given—including cost of equipment, event duration, types of photographic record, repetition rate, exposure duration and time scale. Article also describes operation and characteristics of major cameras, with typical applications in piston engines, vibration in structures and fluid flow through an impeller.

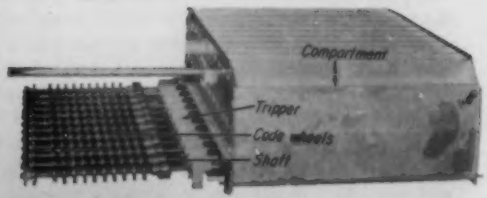
Measurement and Control of Chatter in Gear Drives, Dec '56, p 168. Gear-drive chatter is analyzed with the Geiger Torsiograph. Equations are developed for computing speed variations and eccentricity, and general recommendations are given concerning gear reducers and motor drives.

For measuring RPM — Which Tachometer Nov 10 '58, p 89. With table, and sketches of various types.

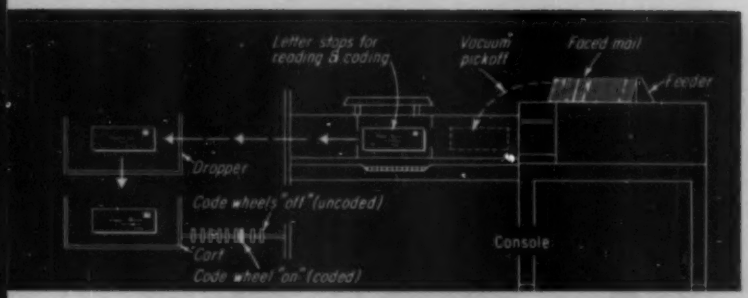
This mail-sorting system uses rollercoaster ramp, plastic code wheels and multilevel chain conveyor to reduce tedious hand labor. Keyboard operation routes letters from 12 operators to 279 destination bins.

Coded Carts Speed the Mail

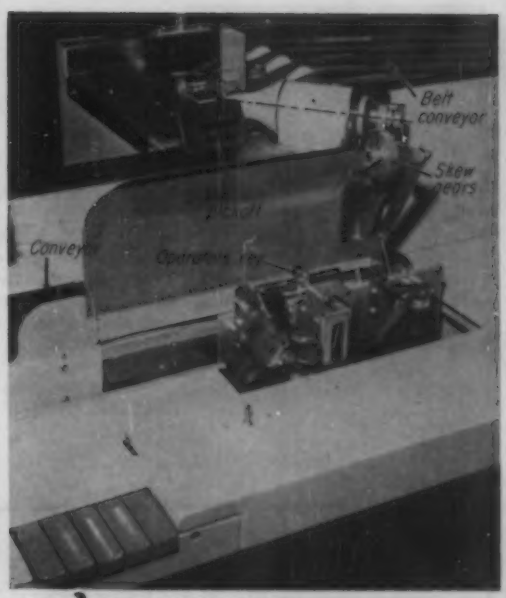


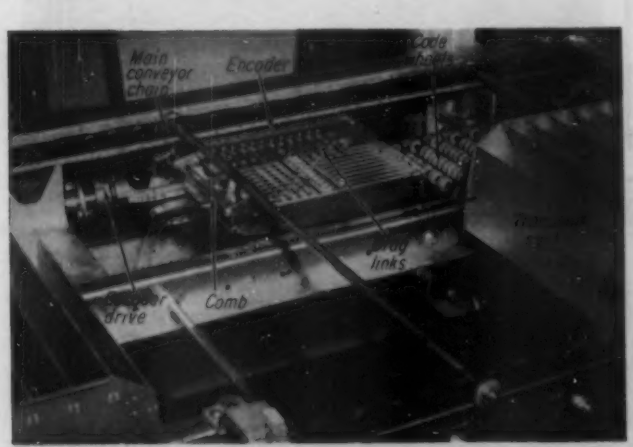


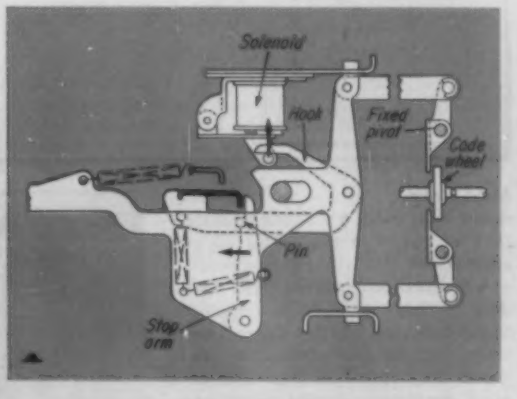
Flow pattern . . .
of faced-and-cancelled letters starts at the operator's station, passes to the input level of the conveyor and then proceeds to the destination bins located at rear of the sorter. Mail is deposited in transport carts mounted on the multilevel conveyor system. Each cart has 12 compartments, one per operator. Each compartment has a hinged bottom controlled by position of the attached code-wheel system. Position of the code wheels determines where the letter in each compartment is dropped. System has 161 carts on the 4 levels; 12 carts are in process of loading, the remainder are in 3 output levels discharging mail to destination bins. Any letters dropped accidently land on an endless belt beneath the conveyor system and go into a bin at end of the machine.

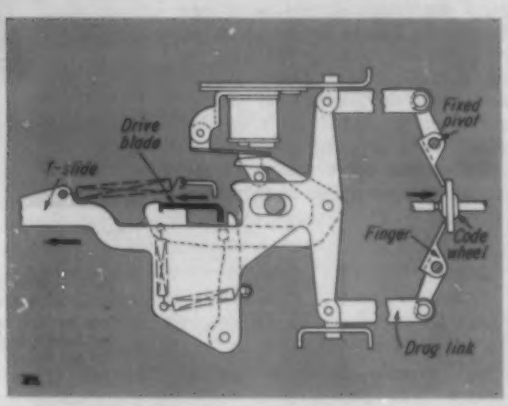


Operator's station . . .
consists of a mail feeder, a 10-key console for coding, and the dropper which deposits the letter into the transport carts. Mail loaded on the feeder is moved toward the operator on a belt conveyor. A vacuum pickoff head rotates each letter onto a console conveyor, which moves it past the operators for reading and coding. A sleeve valve in the spindle of the pickoff head alternately connects the head to vacuum or atmospheric pressure as the skew gears rotate the spindle. An operator's key marks each piece of mail so errors can be traced and corrected; as each piece passes operator, he presses the appropriate keys for the code number that corresponds to given destination. The dropper takes mail from the console conveyor and deposits it into one of the cart compartments.





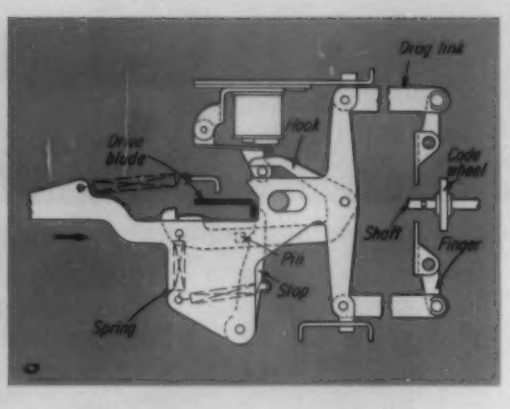




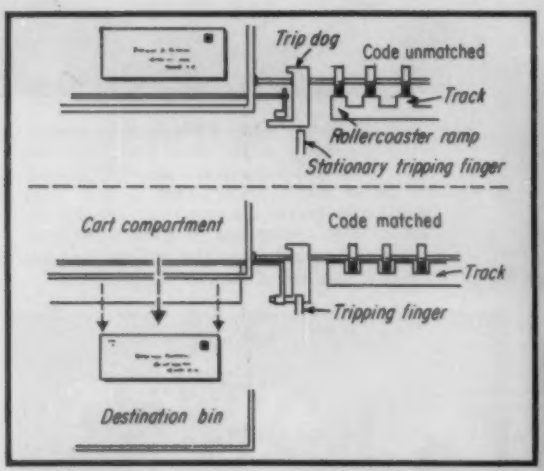
Encoding section . . .
of each operator's station translates the number selected by the operator to the code-wheel position required to deliver the letter to the selected destination bin. When the operator presses a combination of keys on the console, it positions the code wheels attached to the transport cart compartment into which the letter is dropped. The encoder is set by solenoids operated by the keyboard but is driven by the main conveyor chain through sprockets, shafts and a cam.

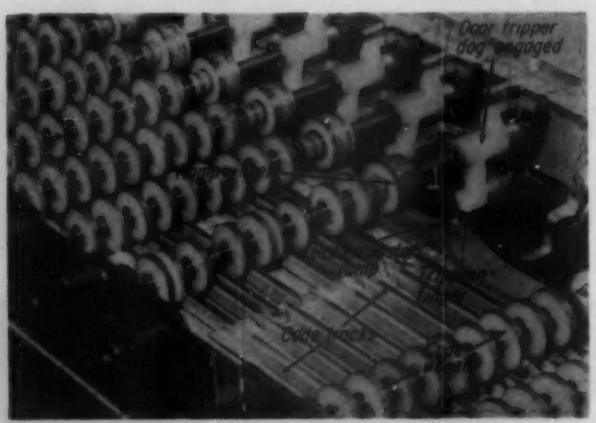
When the solenoid circuit is momentarily energized (A) it lifts the hook to the engaged position and a spring-loaded stop arm slips under a pin mounted on the hook. Initial movement of the drive cam moves the drive blade to the left (B). Hook pulls the T-slide assembly to the left and pushes code wheel to the right or coded position.

(This sequence continued on page 56)

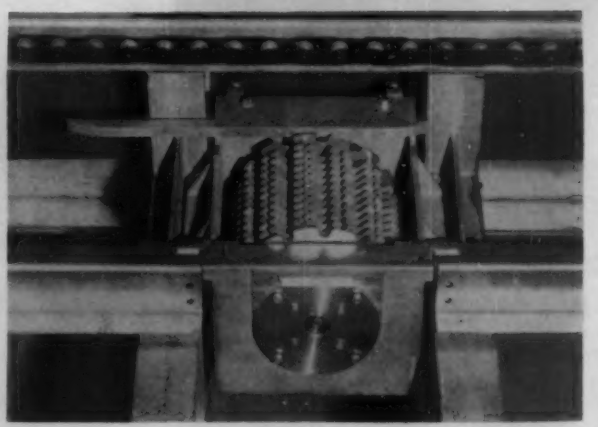


A garter spring in bore of the code wheel engages a groove in its shaft for positive positioning. Cam action reverses the direction of the drive blade to the right (C). The drive blade moves the stop to the right, pushing the stop from under the pin and allowing the spring-loaded hook to drop. The drive blade overtravels to the right, returning the T-slide assembly and fingers to the normal position. Safety comb after encoder checks wheel position, stops sorter if any code wheel is not in one of two permitted positions.





Mail drop . . .
occurs when coded wheels match coded track of output section. This allows unsupported shaft to follow contour of rollercoaster ramp which limits shaft drop. When shaft drops, tripping-fingers mounted on the side of the ramp, one for each destination bin, engage the door-tripper dogs. The engaged dog rotates, forcing the tripper to open the door in the bottom of the compartment, dropping the letter to the destination bin. Letters are removed from the bins by hand. As cart moves on, it passes over a decoder which resets all code wheels in decoded position before the empty cart returns to input section of the sorter.



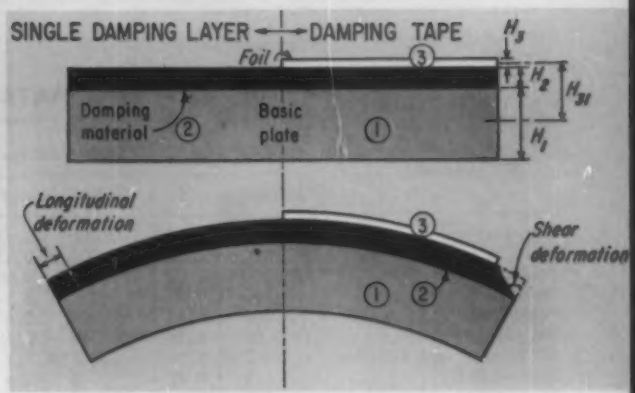
PS . . . With the old 49-pigeonhole rack, a US Postal Service clerk can route 1000 pieces of mail/hr. The automatic sorter averages 3000 letters/hr for each operator—and as high as 43,000 pieces with 12 operators. The sorting system was developed by Detroit Engineering Dept, The Burroughs Corp, Detroit. (See PE—Jan 11, p 16, for full details on Uncle Sam's postal plans calling for all-automation by 1962.)

they cut fatigue failures in flexing structures . . .

DAMPING TAPES FOR VIBRATION CONTROL

Author describes a cheap, reliable, and lightweight way to dissipate excess vibratory energy – keeping resonance stresses low. Basic equations and sample problem show how.

DR ERIC E UNGAR, *senior engineering scientist*
Bolt, Beranek and Newman Inc
Cambridge, Mass



1 ENERGY-ABSORBING ACTION COMPARED for single damping layer (left) and tape (right) which is a damping layer plus metal foil. Foil constrains the damping layer and makes it deform in shear—absorbing more energy than longitudinal deformation of single layer.

The mastic undercoating applied to your new car reduces noise because of visco-elastic damping. When the damping layer is increased, as with a carefully engineered tape, you have a new and effective way to reduce sharply the vibration stresses in a system, particularly at resonance. The tape allows more freedom when designing elastic structures subject to forces over a wide frequency band: (1) natural frequencies need not be kept outside the exciting-frequency range; (2) continuous-speed charts no longer require "red-lining" to avoid resonant speeds; (3) extra stiffening, normally added to brace against resonance loads, can be reduced or eliminated.

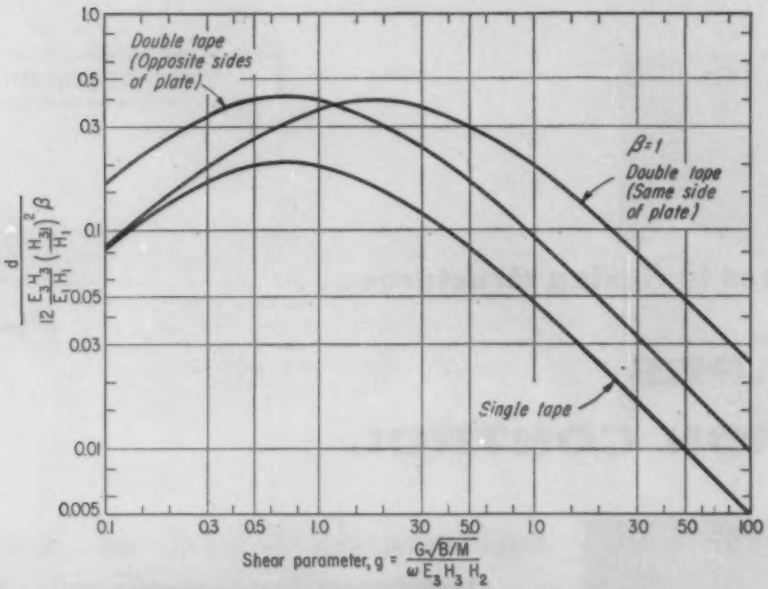
To these advantages, add the versatility of damping tapes as an energy-dissipation technique:

- They can be made in any easy-to-apply form
- Several tapes can be superposed to get the right damping effect without designing a special tape for each application
- High damping at low frequencies (generally, the most troublesome) becomes possible
- Good damping can be obtained over a reasonably wide range of frequencies—from below 40 to over 600 cps.
- Damping effect can be predicted reliably from theory, reducing trial-and-error development to a minimum
- Thermal barriers can be built-in, for special cases.

TAPE VS OLDER METHODS

Damping is simply the removal of energy from an oscillating system. Many damping methods for plate and shell structures are theoretically possible. The main practical problem is to obtain a sufficient amount of damping without excess weight and undue mechanical complexity. One of the most obvious means of damping employs friction between two surfaces in relative motion. It's sometimes done with fibrous or highly viscous materials between the two contacting surfaces.

Capitalizing on the inherent damping in a highly dissipative material is a less obvious way. Such material may be applied in a single layer, as with auto undercoatings. This type of coating absorbs energy by extending and contracting longitudinally when the baseplate bends (see left half of Fig 1). Amount of energy absorbed per oscillation depends on the mean longitudinal strain



2 DAMPING FUNCTION for three tape configurations shows tapes can provide significant increases in damping effectiveness d over wide range of frequency ω. Two tapes on opposite sides of a plate double the single tape damping effect over identical frequencies. Superposed tapes give about the same max damping, but the curve shifts to right—giving best damping at lower frequencies (high g-values). For design, other families of curves should be plotted for other values of loss factor β.

PROPERTIES OF DAMPING MATERIALS

Material	10–100 cps		100–1,000 cps		1,000–10,000 cps	
	G (psi)	β	G (psi)	β	G (psi)	β
Polypropylene	100,000	0.11	110,000	0.15	.....	....
Polytrifluorochlorethylene	140,000	0.11	200,000	0.15	.....	....
Polyvinylchloride (PVC)	190,000	0.03	200,000	0.032	200,000	0.04
Polyisobutelene	60	0.5	230	1.1	300	1.8
Filled Nitril Rubber	7,000	0.4	13,000	0.6	29,000	0.8
3M #428 adhesive*	29	0.55	54	0.62	130	0.75
3M transfer tape adhesive	2.3	1.2	7.3	1.4	.....	....
Foamed PVC	9	0.27	19	0.6	.....	....
Buna N, B-5	700	0.6	1,300	1.1	2,900	1.5
Buna N, B-1	600	0.48	900	0.9	2,000	1.2
Buna N, B-0	330	0.57	540	0.8	900	1.3
Natural gum, N-1	100	0.06	120	0.12	140	0.21
Neoprene, CG-1	.....	....	.....	.....	6,000	0.33
Butyl, U-50	.....	....	.....	.....	7,000	1.7

Mean values at 70 F, in three frequency ranges (G = shear modulus; β = loss factor)

* Designed for high temperature, where better damping than shown here is obtained.

induced in the coating, and this strain increases with thickness of the coating application. Degree of damping is therefore limited by thickness and weight restrictions.

As an alternate technique, the strain in the dissipative material, (and thus the damping provided by it) can be increased if the coating is applied atop a "spacing layer"—stiff in shear, but not too stiff in extension. Effectiveness here clearly depends on the thickness and stiffness of the spacing layer. Though this alternative can reduce weight, excess thickness and complexity are still problems.

Damping tapes are a better answer. When a thin, extensionally stiff foil is placed on top of a thin layer of dissipative material (an adhesive, for example), this material is subjected to large shear strains (see right half of Fig 1) which produce considerable damping. Such a composite material can be made relatively thin and light, and can be made as an easily applied adhesive "tape."

HOW THEY WORK

The damping effect of a damping tape on a plate has been investigated extensively. For the common tapes, usually quite thin compared to the baseplates, damping effectiveness d obeys the approximate relation

$$d = \frac{12\,\frac{E_2 H_2}{E_1 H_1}\left(\frac{H_m}{H_1}\right)^2 \beta g}{1 + 2g + (1+\beta^2)\,g^2} \qquad (1)$$

where the dimensions H_1, H_2, H_m are shown in Fig 1; E_1 and E_2 are the moduli of elasticity of the basic plate and the tape foil, respectively; and β is loss factor of the dissipative material. Typical good damping materials have loss factors between about 0.2 and 2.0 (see Table). The d-factor is one of many common measures of damping.

In Eq (1), g is a dimensionless "shear parameter" which governs the damping and is given by:

$$g = \frac{G\,(B/M)^{1/3}}{\omega\, E_2 H_2 H_3} = \frac{G\,H_1}{4\pi f\, E_2 H_2 H_3}\left(\frac{E_1}{3\rho_1}\right)^{1/3} \qquad (2)$$

where G is shear modulus and H_2 is thickness of the adhesive dissipative layer; B is the flexural rigidity and M the mass per unit area of the plate; and ω denotes circular frequency of the oscillation. In the second form, f de-

SAMPLE PROBLEM SHOWS WHAT DAMPING TAPES CAN DO

The Square Plate

Consider a square plate simply supported on all four edges and exposed (on one side) to an oscillating pressure. Such a plate might be an idealization of, say, a panel in an aircraft bulkhead. Assume that sinusoidal pressure oscillations can occur within a wide range of frequencies (due, for example, to a piston-type compressor being driven at various speeds), so that resonances cannot be avoided. Assume further, for simplicity, that pressure amplitude P does not change with frequency.

Max stress in the plate occurs at resonance of the plate in its lowest mode, at a frequency given by

$$f = \frac{\pi}{2} \cdot \frac{H_1}{b^2} \cdot \left(\frac{E_1}{3\,(1-\mu^2)\,\rho_1} \right)^{1/2} \qquad \text{(i)}$$

Here b denotes the edge length of the square plate, μ is Poisson's ratio of the plate material, and the other symbols have been previously defined. Max stress is given by

$$\sigma_{max} = \frac{2E_1 P}{\pi^2(1-\mu)b^2\,\rho_1 f^2 d} = \frac{24\,(1+\mu)}{\pi^4} \left(\frac{b}{H_1} \right)^2 \frac{P}{d} \qquad \text{(ii)}$$

The last form of the stress equation reveals three steps that can be taken to reduce the stress:

1) decrease unsupported panel and span b
2) increase plate thickness H_1
3) increase the damping d

The stress can be reduced by a factor of 4 by doubling the plate thickness (which doubles the weight) or halving the unsupported span length (which doubles complexity of the structure). Since the internal and edge damping in a bare steel or aluminum plate is of the order of $d = 5 \times 10^{-3}$ and well-designed damping tapes can produce damping of the order of $d = .05$, it appears that damping tapes can reduce the stresses at resonance by a factor of about 10 with a relatively small increase in weight and complexity.

Designing the Tape

To illustrate some of the calculations involved, consider a 0.1-in.-thick aluminum panel, 12 in. square, exposed to a pressure amplitude of $P = 0.025$ psi. Assume damping due to various sources, such as energy loss at the edges, gives an effective $d = 5 \times 10^{-3}$. Then, from Eq (ii), max stress (with no tape) at resonance will be

$$\sigma_{max} = \frac{(24)\,(1+0.3)}{\pi^4} \left(\frac{12}{0.1} \right)^2 \frac{0.025}{5 \times 10^{-3}} = 23{,}000 \text{ psi}$$

This stress level may affect the fatigue life of the panel severely.

Since for aluminum $E_1 = 11.5 \times 10^6$ psi and

$$\rho_1 = \frac{0.1}{386} \frac{\text{lb sec}^2}{\text{in.}} / \text{in.}^3,$$

Eq (i) gives the frequency of the lowest resonance as

$$f = \frac{\pi}{2} \frac{0.1}{(12)^2} \left(\frac{11.5 \times 10^6}{3\,(1-.09)\,(0.1/386)} \right)^{1/2} = 140 \text{ cps}$$

A well-designed damping tape should operate at a value of shear parameter g near unity, Fig. 2. Although these curves are plotted for $\beta = 1$, the value of the function near $g = 1$ is not strongly influenced by values of β between 0.3 and 1.3—Eq 1. With $g = 1$, shear modulus G is calculated from Eq (3)

$$G = \frac{f E_2 H_1 H_2}{8600\,H_1} = \frac{(140)\,E_2 H_1 H_2}{8600\,(0.1)} = 0.163\,E_2 H_1 H_2$$

The damping effectiveness d can be computed in terms of the loss factor β. For a single tape, from Fig 2 for g near unity,

$$d = (0.2)\,(12)\,\beta \frac{E_2 H_2}{E_1 H_1} \left(\frac{H_2}{H_1} \right)^2$$

This clearly shows that a stiff foil (large values of E_2H_2) gives good damping. Hence, consider a 3-mil-thick steel foil. For a thin tape $H_2 = \frac{1}{2} H_1$, as seen from Fig 1. Then, with $E_2 = 30 \times 10^6$ psi for steel and $H_2 = 0.003$ in., the shear modulus G at 140 cps simplifies to

$$G = (0.163)\,(30 \times 10^6)\,(0.003)\,H_2 \text{ or}$$
$$H_2 = G/14{,}700 \qquad \text{(iii)}$$

$$d = (0.2)\,(12)\,\beta \frac{(30 \times 10^6)\,(0.003)}{(11.5 \times 10^6)\,(0.1)} \left(\frac{1}{2} \right)^2$$

$$d = 0.047\beta \qquad \text{(iv)}$$

The problem becomes one of selecting from the table, a dissipative material with a large β at 140 cps—giving maximum damping d from Eq (iv). Then, the thickness H_2 of the dissipative layer must be selected to satisfy Eq (iii), using the shear modulus G at 140 cps. The thickness H_2 thus calculated must be "reasonable" from several standpoints. It should not: add too much weight, be too large for easy handling and fabrication of the tape, or be too thin for good tolerance control. Otherwise, a different material (with different β and G at 140 cps) must be selected.

Selecting polyisobutelene gives $\beta = 0.8$ and $G = 150$ (by interpolation from table at 140 cps) and

$$d = 0.047\,(0.8) = 0.0375$$
$$H_2 = 150/14{,}700 = 0.0102 \text{ in.}$$

Thus a tape made up of 3 mils of steel and 10 mils of polyisobutelene would reduce the stress at resonance by a factor of

$$\frac{\sigma_{\text{no tape}}}{\sigma_{\text{with tape}}} = \frac{d_{\text{with tape}}}{d_{\text{no tape}}} = \frac{0.0375}{0.005} = 7.5$$

with only about a 15% increase in weight. A multiple tape is clearly unnecessary here, since a single tape cuts the maximum stress from 23,000 psi to 3,060 psi. If the single tape reduction were inadequate, however, the effect of two tapes could be quickly calculated from Fig 3: Entering the chart at $g = 1$ (near optimum damping, Fig 2), the damping ratio for $\beta = 0.8 \cong 1$ is about 1.8. Thus max stress would be $3060/1.8 = 1700$ psi.

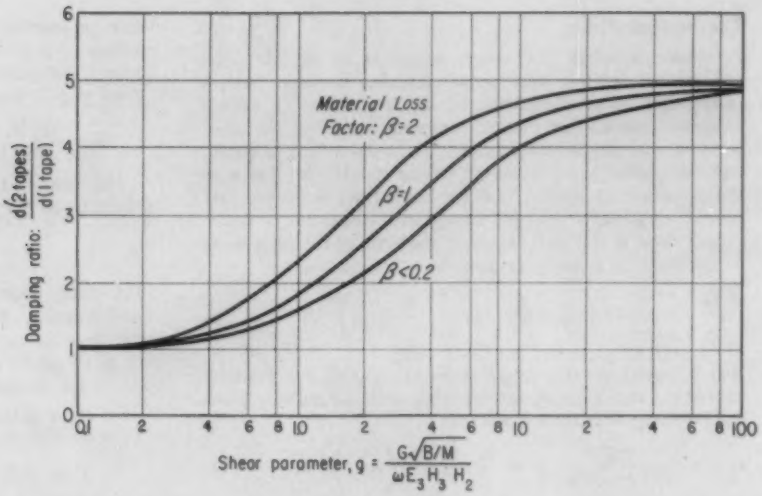
This sample problem illustrates the general method of tape design. Other, possibly better tape designs are feasible, and may be carried out in a similar manner. In practice, other factors can affect results: frequency range to be covered, temperature dependence of material properties, adhesive qualities, corrosive effects, aging, costs, availabilities of the dissipative materials.

notes frequency and ρ_1 the density of the plate. Consistent units must be used throughout: For plates made of steel or aluminum, with E and G in psi, H in inches, and f in cps, Eq (2) reduces to

$$g = \frac{8600}{f} \cdot \frac{G H_1}{E_2 H_2 H_2} \qquad (3)$$

The shear parameter g is also capable of physical interpretation; it can be shown that g depends on ratio of the vibration wavelength to distance within which a localized shear disturbance decays to a certain fraction of its value. Thus, g is related (in a complex way) to how much shear a flexural oscillation produces.

From Eq (1), plotted in Fig 2 for one value of β, damping effectiveness d varies nearly linearly with g for



3 DAMPING-RATIO CURVES are useful when converting a one-tape design into a design with two tapes superposed (see sample problem). Note that for optimum damping ($g \simeq 1$, Fig 2), picking a dissipative layer with the highest β value can make a double-tape system nearly three times as effective as a one-tape system.

small values of g (high frequencies), reaches a maximum at $g = 1/(1 + \beta^8)^{1/6}$, and varies nearly inversely with g for large values of g (low frequencies). Eq (1) may be used as the basis for designing damping tapes. In practice, however, the effect of frequency and temperature on β and G for the dissipative material must be accounted for. Properties of the foil and plate can also be affected.

MULTIPLE TAPES

When designing damping tapes for massive structures, the calculated foil thicknesses are often so great that the tapes would be difficult to handle. Two tapes can then be specified—one each side of the plate, and each giving half the required damping. If one side of the plate must be left uncovered, a good answer is a double-tape arrangement—one tape placed atop another just like it. Damping behavior obtained by this superposition is shown in Fig 2, and is different from those obtained with tapes on opposite sides of the plate.

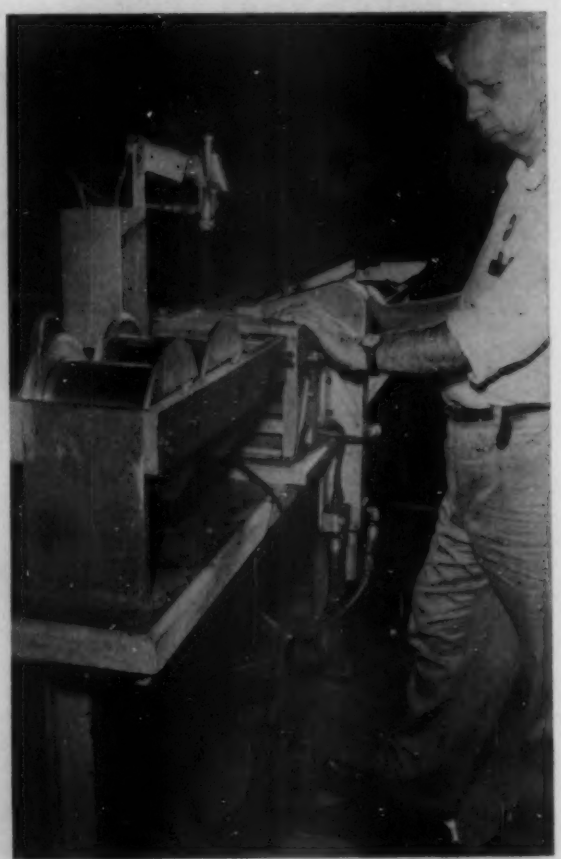
Comparing the curves shows that two tapes behave like a single one at high frequencies (low g) but are much superior to a single one at low frequencies. For both, it is possible to design tapes to produce significant damping over a reasonably wide frequency range of interest. The ratio of double to single-tape damping for various values of β, Fig 3, may be used with Eq (1) and (2) to design double damping tapes.

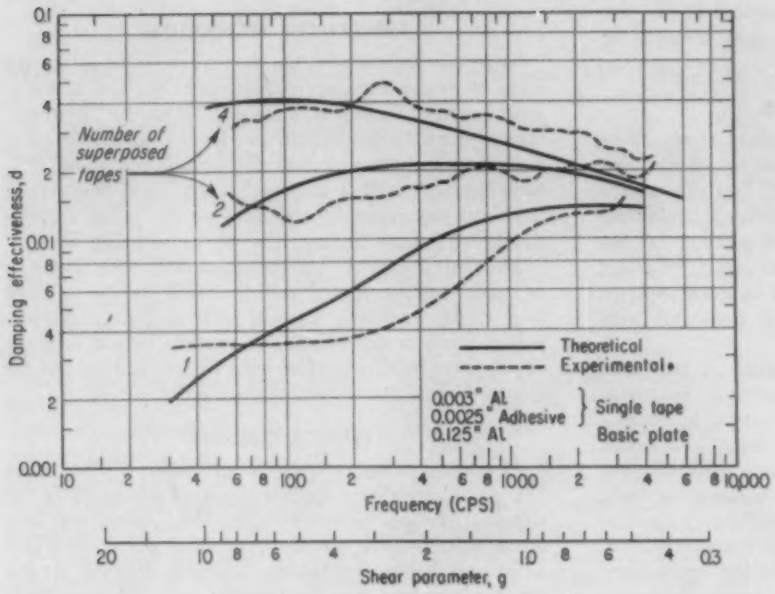
The damping action of two superposed tapes is very nearly that of a single tape with a foil thickness equal to the sum of the foil thicknesses of the individual tapes, but with a damping material thickness of only one of the tapes. Equally important this relation appears to hold also if the component tapes are of different foil thicknesses, and for more than two tapes. These simplifications hold as long as total thickness of the tapes is less than about one-fourth of the basic-plate thickness.

Designing with multiple tapes gives maximum flexibility, considering the limited number of tapes available. For example, Fig 4 shows how a single tape superposed four times can multiply damping effectiveness nearly 10 times

(TEXT CONTINUED, p 62)

DAMPING TAPES APPLIED . . .





4 THEORY VS EXPERIMENT shows good correlation for several multiple-tape arrangements. Better agreement is expected as more accurate data on the dynamic elastic properties of damping materials become available. Four-layer tape system gives great improvement at low frequencies, but weight penalty can prove prohibitive.

. . . TWO WAYS FOR NOISE CONTROL

MAKE YOUR OWN TAPE: Catalyzed adhesive as the damping layer is sprayed (left) onto thin aluminum sheet fed from rolls. Cut to length, coated panels are then fitted (above) to fuselage between stringers of Convair 880 jet transport. Final step is to smooth tape firmly in place with a squeegee action. Noise analysis showed tape was needed to damp out air noise rather than engine noise.

USE COMMERCIAL TAPE: On its new YHC-1A helicopter, Vertol Aircraft found that turbine and transmission noise set up resonance in fuselage panels. A commercial tape solved the problem. Workman here strips pressure-sensitive aluminum foil off rolls, and fits it between stringers and around windows like wallpaper. Tape used in this application is 3M's Type 428-A.

DAMPING TAPES (CONTINUED)

at low frequencies. It also shows the relatively good agreement obtained between the theoretical results outlined above and experimental data in spite of some inherent experimental difficulties.

APPLYING THE TAPES

Despite the wide use of pressure-sensitive tapes (*PE*—Mar 2 '59, p 57), commercial manufacture of damping tapes in variety is just getting started. You can accomplish much, however, with multiple layers of established tapes. Or—devise your own tape. The problem (as the accompanying example shows), in either case is to adjust the shear modulus G and thickness H_s of the dissipative layer to get the best energy absorption consistent with easy handling and installation.

Most of the dissipative materials listed in the table can be obtained as mastic or as sheet material. In mastic form, they can be spread by hand or sprayed in place—with the metal foil laid over like wall paper. For some materials, adhesives may be required to join the dissipative materials to the base metal and the constraining foil. Since thickness of mastic is hard to control during application, design based on mastic should call for a relatively thick dissipative layer. Normal variations during application will then be small compared to total mastic thickness, and variations in shear parameter g will be negligible.

Vibration damping is useful also for noise suppression. Here, light and effective designs employ a high-shear adhesive—applied to the foil as manufactured, or by spray at installation (see photos). Several aircraft manufacturers are applying this type of damping tape to aircraft fuselages as a noise-control measure, and are also considering their use on airframes to control fatigue.

SPECIALIZED TECHNIQUES

There is occasionally no dissipative material in the table to fit the necessary requirements for loss factor β, shear modulus G and thickness H_s. If so, an "apparent" tape of the right proportions can be created by separating a thin tape (damping material plus constraining foil) from the plate with a shear-stiff spacer. For best results, the shear modulus/thickness ratio for the spacer material should be at least 10 times that of the damping layer.

Thermal insulation can be combined with damping by replacing the spacer and/or metal foil by a thick layer of an insulating material such as foamed plastic—polyurethane or polystyrene. A possible loss in damping effectiveness by this method must be weighed against the gain in thermal insulation that the method affords.

WHAT'S COMING?

At present, damping tapes (which sometimes look more like metal sheets) are applied to all, or nearly all, of the vibrating surface. Selective application—where and how much tape to apply for most damping per lb of added weight—is being investigated. Adding 10-15% to the structure's weight may be tolerable in most cases; however, localized application might cut this to perhaps 5%. Designing visco-elastic damping right into the structure, in sandwich form, is another very effective damping technique under scrutiny.

REPRINT COPIES of this report are available for 25 cents each by addressing Reader Service Dept., Product Engineering, 330 W 42nd St, New York 36, NY.

EDITOR'S NOTE: This article introduces damping tapes as an unusual way to absorb energy. Here are some recent articles on other methods:

Saving Space with the Liquid Spring, Aug 17 '59, p 54—spring action given by a liquid has proved itself in aircraft, and is now moving into industrial applications.

Glass-fiber Sleeve-springs for High Energy Absorption, Aug 17 '59, p 60—how to design a new kind of spring that can absorb almost 5 times the energy handled by steel springs.

Dry-friction Damped Isolators, Aug 3 '59, p 48—curves compare this type with better-known viscous isolators; new equations predict vibration-transmissibility characteristics of dry-friction type.

Vibration Isolators with Zero Stiffness, Sept 29 '58, p 52—7 spring arrangements that give constant force over a limited range of deflection.

New Shock Absorber, May 12 '58, p 86—this 2-part sleeve spring has resilient core and restraining girdle of silicone rubber; combination gives smoothly rising spring rate and high energy capacity.

Rubber Vibration Isolators, July '57, p 140—new method of analysis predicts performance by accounting for creep of visco-elastic materials.

Damping Capacity of Materials, Nov '54, p 164—inherent damping capacity of structural materials is an important means of limiting resonant stresses and amplitudes of vibration. Article compares basic materials, and shows how to build damping into uniformly and nonuniformly stressed members.

your index is ready

A 16-page printed index of all editorial content in the issues of the last six months of 1959 is now ready. Copies may be obtained by writing "Index Vol 30-2" in the space marked Special Data on the Reader Service Card bound in this issue.

THIS INDEX INCLUDES

- *a subject-classified breakdown of all editorial content*
- *an alphabetical index of authors*
- *an index of company names mentioned in connection with important news or developments.*

The index is issued twice each year in July and January, and single copies will be sent free on request as long as the supply lasts. A limited supply of the index for the first six months of 1959 (Vol 30–1) is still available.

7 steps to better oral reporting

E J TANGERMAN, editor

step 1: From ideas to outline
step 2: How to organize a talk
* step 3: Now you need notes
step 4: Hints on delivery
step 5: Platform manners
step 6: Chairing committee or panel
step 7: Chairing a meeting

* 3 . . . The paper is written . . . What Now?

Once the written version of your talk is completed, you've only begun. The text is a factual report or chain of statements, with or without human interest. But you must now edit. Have you included the needed illustrations? Are your explanations clear and straightforward? Can some of your explanations be dropped? Should standard references be consulted for supporting quotes? Is your story complete?

Now consider it from the public-relations angle. Have you given credit where it is due, told your own story without invidious comparisons? Have you displayed those sixth and seventh senses, tact and modesty? Are the thoughts in good taste?

Next, polish the language. This doesn't mean "go highbrow," either in choice or arrangement of words. Just check to see whether an active verb can replace a passive one, a good crisp phrase replace a trite one, and so on. Relax your stiff sentences, warm up your cold ones. Check your calculations. Get a clean manuscript copy and check that for typographical errors.

The Speech vs the Paper . . . You've written your paper. It is clear, logical, gives all necessary details. This is for the record, but it is *not* a speakable speech. A reader of your paper can reread to clear up a missed or misunderstood point; the listener cannot. So you must now prepare a simpler, less detailed, shorter, speaking version. The skilled speaker merely makes notes, particularly if his subject is broad, but it is safer on a specific technical topic to prepare an actual abstract that you can read in the allotted time. This helps you avoid drifting from your subject.

However, a written abstract is not a speech either; it will inevitably be too condensed. You'll find you must add words and phrases to space out the ideas and make them graphic. The ideal way is to make your speech to a secretary from notes, trying to get your points across to her. You'll find the "talked" abstract is two to three times as long as the written one.

That's customary in conversation. A speech from notes, transcribed, is full of extra words and phrases, even sentences, that can be cut out and still leave a completely understandable reading version. Even with the advantages of facial expression and gesture to accompany the words, you will find it necessary to "fill in" some words while your auditors absorb each of your ideas. Also, unless the occasion is very formal, you'll want to relieve listeners' tension by using occasional slang or colloquialisms, even making a wisecrack or telling an appropriate story. You'll find that, with experience, you tend to skip the stories, relying instead upon interesting phrases, humorous and satirical sentence twists, and smiling asides to enliven what you say.

There's a standard trick that detours all this effort and makes your speech sound extemporaneous. Put the *entire* speaking version on cards—they'll look like notes on the platform. Live with the cards for several days. Carry them in your pocket and reread them at every opportunity. Underline the words and phrases you want to stress. Let the words and sequence of ideas soak into your mind, but DON'T try to memorize. And DON'T try to make last-minute changes.

You will find the cards becoming familiar. You can now speak from them with only an occasional glance —a glimpse of a word or two will recall a whole sentence. Thus you'll avoid a mechanical, word-by-word reading, or the dull plodding of a memorized speech. (Proper memorizing must be done like an actor does it—by constant rehearsal, complete with gestures, movements and interpretations under the eye of a skilled director.)

The Outline . . . If you prefer, you can outline your major points and expand from them. Again, the most usable form is cards, 3 x 5 in. or 5 x 8 in., with a new card for each major thought. The trick is to outline the whole thought, not just a key word or two. Then you have a solid skeleton for the speech, even if you panic on the rostrum. It is advisable to note important numbers, especially good phrases and the like, because your mind will offer several sets of words to phrase each thought while you're speaking, and you want the best.

If you are using slides, provide a separate card for each. Then, if one slide gets out of order, you can usually save the day. Include cards with facts that may be asked for in discussion. And if your eyes are beginning to show your age, have the cards typed or lettered with over-size letters so you can read without glasses.

Last step in preparation is to deliver the talk aloud several times, first in the privacy of the furnace room, then to a tape recorder or to the family or whoever will listen. Time it each time. Think about gestures, movements, facial expressions. Even a lifted eyebrow is a gesture. Figure a minute apiece for technical slides, half a minute for general views and scenes. If your paper is to be preprinted or reprinted, your presentation need only be 20 to 30 minutes. A full-fledged speech today rarely exceeds 45 to 60.

Next week we'll actually deliver the speech. . . .

A reprint will be available including all seven lessons in this series. To get your copy, circle P42 on Reader Service Card.

THE SEELY BOX, named for the author, permits measurement of motor winding resistance while the motor drives the load.

When the duty cycle of the load is known, it can be matched to a motor by a shortcut technique described recently in "Prediction of Induction-motor Performance," (Dec. 21 '59, p 42). The method described here by Mr Seely shows . . .

how to determine

DUTY-CYCLE from MOTOR-WINDING RESISTANCE

RICHARD E SEELY
General Purpose Motor, General Electric Co

Winding temperature as an indication of load can be read directly by thermometers or thermocouples, or it can be calculated from change in resistance of the winding. Each method has its limitations.

A thermocouple measures only spot temperatures, with possibility of a considerable time-lag when temperatures change rapidly. The size, location and method of application may introduce wide variations in readings, and installation is usually difficult, particularly in enclosed or hermetically sealed motors.

Thermometers also offer problems when applied directly to windings—first, in getting at the hot spot of the winding, and then getting good thermal contact.

With the winding-resistance method, the drive usually is shut down after a period of running; then resistance of the motor winding is measured. An approximation of the cooling curve can be constructed by taking readings at frequent intervals, and the temperature at shut-down can be approximated by extrapolating the cooling curve to zero time. This method is inaccurate, time consuming, and particularly difficult under changing load conditions. What is needed is a method of making direct and continuous resistance measurements under load.

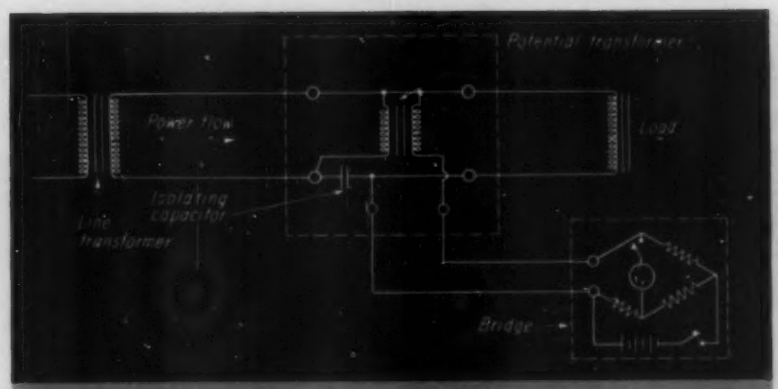
Obviously, a direct-connected bridge or ohmmeter would be damaged by the ac voltage, and the resistance in parallel circuits would complicate the reading. But these limitations can be overcome by supplying a bucking ac voltage from a potential transformer, as shown in the elementary diagram. External parallel resistances on the line side are isolated with a capacitor. Resistance in the secondary of the potential transformer is constant and is subtracted from the total to obtain motor-winding resistance.

Winding temperature T_h corresponding to a hot resistance R_h is calculated from the cold temperature T_c and the cold resistance R_c by:

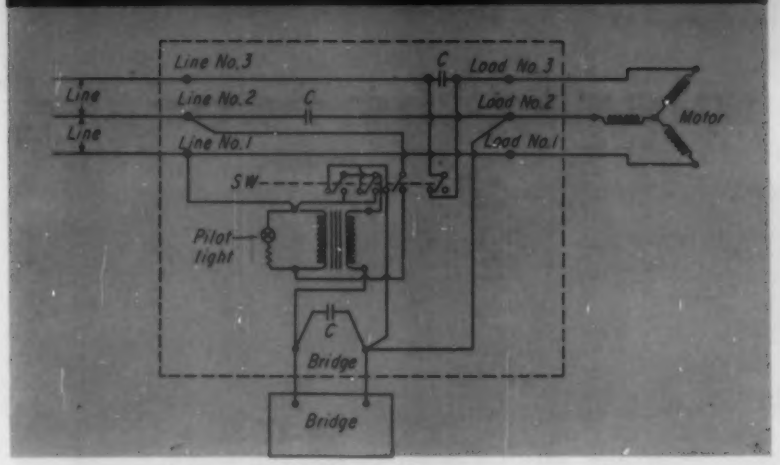
$$T_h = (R_h/R_c)\ (K - T_c) - K$$

where K is 390.1 for copper (temperatures measured in °F) and 365.8 for aluminum; corresponding values for temperatures in °C are 234.5 for copper and 221.0 for aluminum.

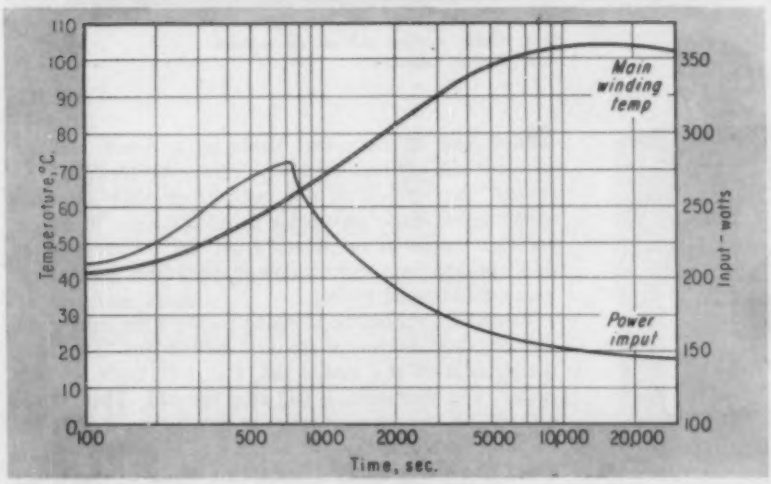
A test instrument to measure polyphase windings with grounded neutral requires a capacitor in each supply line.



TO DETERMINE MOTOR TEMPERATURE, winding resistance is measured under load by bucking the ac with a potential transformer and adding an isolation capacitor. Known resistance of secondary is subtracted to get winding resistance.



TEST INSTRUMENT FOR POLYPHASE MOTORS provides measurement of each phase, and checking for potential transformer resistance. Switch inserts measuring system into line for spot readings without affecting readings of wattmeters or voltmeters between spot readings.



WINDING TEMPERATURE calculated from resistance measurements on a 1/6-hp refrigerator motor as refrigerator was pulled down from room temperature.

The measured resistance of polyphase windings is that of two phases in series for Y-connected and two phases in parallel when delta-connected. A 4-pole switch, used as shown in the circuit, puts the bucking transformer winding and capacitors in the circuit only when readings are made. With the switch in the "off" position the capacitors are shunted in order to obtain accurate readings on the wattmeters and voltmeters.

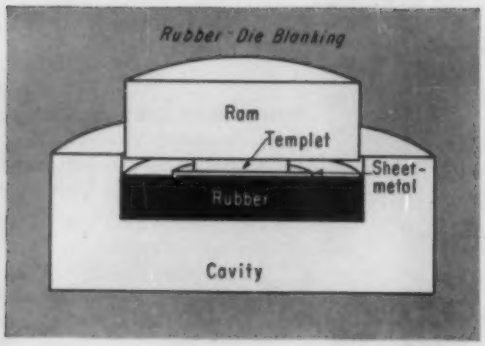
This resistance test device will make spot tests during a heat run, and can also give continuous readings if the potential transformer is warmed up before starting the test. Results of a typical test are shown for a $\frac{1}{3}$-hp hermetic motor driving a refrigeration system as a refrigerator cabinet is "pulled down" from room temperature to its normal operating temperature.

EDITOR'S NOTE: The Seely Motor Tester (patent No. 2578455) is distributed by James G. Biddle Co, Philadelphia.

SHORT-RUN BLANKING BY THE RUBBER-DIE PROCESS

This economical method turns thin sheetmetal into complex shapes. It will handle runs of up to 500 parts—or models for development work. Limitation: blanking gives relatively little depth to the sheet parts.

E J HILLS, *methods and process engineer*
RCA, Electron Tube Div



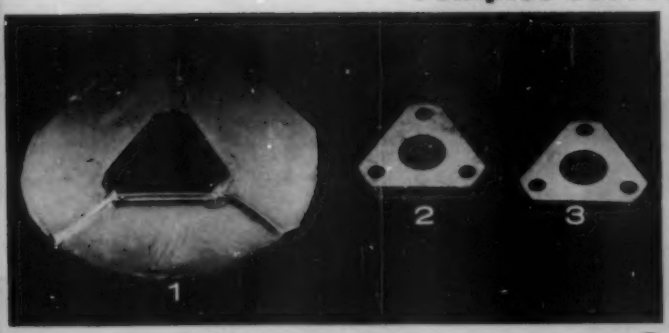
Short runs of sheetmetal blanks up to 5-inch size can be made cheaply and quickly by rubber-die blanking. Although the method is not competitive with short-run stamping for shapes producible by stock tooling, it can cut complex shapes in sheetmetal from foil thickness up to 0.015 in. and form such shallow shapes as ribs and grooves without additional tooling.

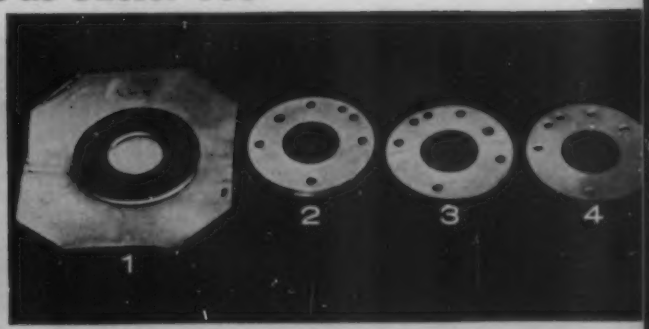
Essentially, rubber-die blanking pushes a flat cutting die through thin sheetmetal set on a rubber pad. The basic tooling consists of a rubber pad, ½ to 1 in. thick, set in a cavity. The sheetmetal is laid atop the pad. Then comes a hardened templet that serves as the cutting die. It has the same outline as the part which is to be blanked—but is about 10 times as thick. A metal ram, which fits the cavity closely, goes on top of the templet.

The whole assembly is now squeezed in a hydraulic press. As the ram enters the cavity, the rubber is compressed and the sheet is sheared between the cutter and the compressed rubber.

Because the templet also does the cutting, ram and cavity can be used interchangeably for an unlimited number of shapes. The rubber pad is about 60 Durometer hardness and can be used for about 3000 to 5000 blanking operations before it needs replacing. The cutting die is ma-

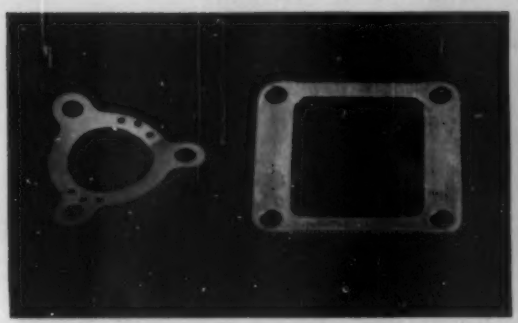
Templet Serves as Cutter Too

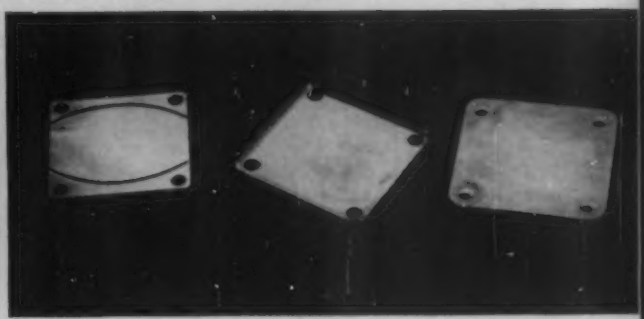




a b

Rubber-die Method—Variety in Detail





c d

chined from flat stock, then is hardened and sharpened by surface-grinding both faces to square the edges. Then the die is honed by a liquid abrasive blast to remove any burrs at the edge. This honing gives better die life and truer edges on the blanked part.

The Blanked Parts

Complexity of shapes is limited only by the ability to machine the cutter. For example, sharp square external corners are simple, while an internal radius should have a minimum of 0.010 in. so that the cutting die can be quench-hardened without cracking. Radii may be as small as 0.005 in. if the part can be heat-treated readily.

Diameter of holes can be as small as 0.005 in. and spaced closer than with metal-die blanking. Since the metal-die method requires slender punches, small holes close together must be punched by progressive steps. In contrast, the rubber die cuts all the holes at one time.

Parts come out flat because the rubber holds and irons the thin sheet stock firmly against the flat cutter as the shape is cut. This eliminates need for a pressure plate to prevent bowing in the part.

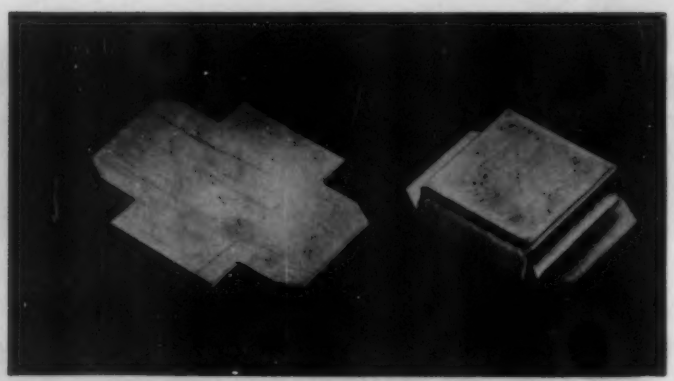
Tolerances of ±0.001 in. are common. The die loses

a Sheetmetal stock (1) looks like this after templet (2) has removed blanked part (3). The three corner holes in blank have diameters reproduced to within ± 0.001 in. of the die.

b Same method gives choice between forming and punching: (1) sheetmetal after cutting; (2) templet with full pressure gives holes in blank (3) and with less pressure and rounded shearing edge, gives dimples (4).

c Narrow web is possible—note closely positioned holes in foil part, left. Fine detail appears in serrated teeth, 0.020 in. apart, in spacer at right.

d Minor forming can give more than dimples (at right): for example, flanged edge at center, and stiffening grooves, left.



Third dimension is added after blanking by folding with a separate die; photo shows how a flat becomes box shape. This method can give deeper parts than those formed with the usual cutting die, which is 10 times' thickness of part.

its sharpness and therefore its ability to cut to close tolerances after about 500 operations—but it can then be resharpened by simply grinding enough off the surface to restore a sharp cutting edge.

Fine details is reproduced accurately. An example of the detail possible at the edge is a serration with teeth 0.020 in. apart.

Maximum dimension is approximately 5 in. dia. with a 6-in. dia rubber die. Some margin or excess stock must be allowed beyond the edge of the blank to avoid wrinkling. A rule of thumb is to make the blank two to four times the area of the cutter. The heavier materials require more margin.

Minimum web between cut-out areas is 0.035 in. This has particular advantages for small intricate parts.

Sharp, square edges without burrs are another advantage. They eliminate need for secondary finishing. This is helpful where parts must be stacked closely against each other as in laminated assemblies.

Minor forming does not require extra tooling. Ribs or grooves for stiffening can be formed during the same blanking step. Small, thin flanges are made by rounding the die edge and reducing blanking pressure. Dimples can be produced, instead of punched holes, by similarly rounding the shearing edge and reducing pressure. Depth of the dimples is approximately ½ the diameter. A right-angle bend requires a separate step (sometimes separate tooling) and is limited in depth to the thickness of the templet.

How the Method Rates

Cost of a simple cutter for the rubber-die process is about $35 to $40 compared to the $1500 price for a cutter giving the same shape in long-run stamping dies. Economical runs are up to 500 blanks where metal-die blanking can be done in a single step and about twice that number where metal die requires two steps.

Because it is essentially a hand operation and because of its higher stock wastage, the rubber-die method cannot compete with short-run stampings for parts that are producible by stock tooling. But it can cut parts that are more intricately shaped and produce them quickly—often within the same day. Where development has not fixed design, changes in shape of the part are also cheaper because there is only one tool, the male cutter.

EDITOR'S NOTE: Mr. Hills was formerly with Westinghouse Electric Corp's Electronic Tube Div where he did the work described in this article.

Other articles on models for preliminary design:

Speed Your New Product with Cast Epoxy Models, Dec 21 '59, p 60. How to convert your new product ideas into actual parts by casting with epoxy resins. Gives shortcut prototypes.

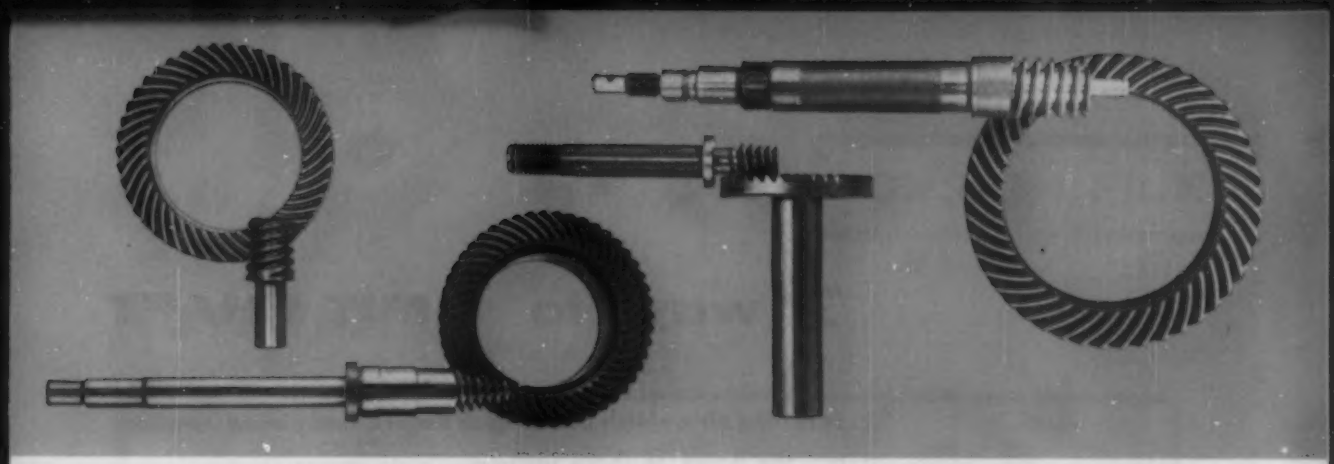
Structural Models — They Preview Stress and Strain, Oct 26 '59, p 55. Three-part report tells how to design structural models, materials to use, and how to test.

Clay Models Will Shape Your Ideas, Oct 12 '59, p 68. A quick, inexpensive way to get a clear image of the proposed component.

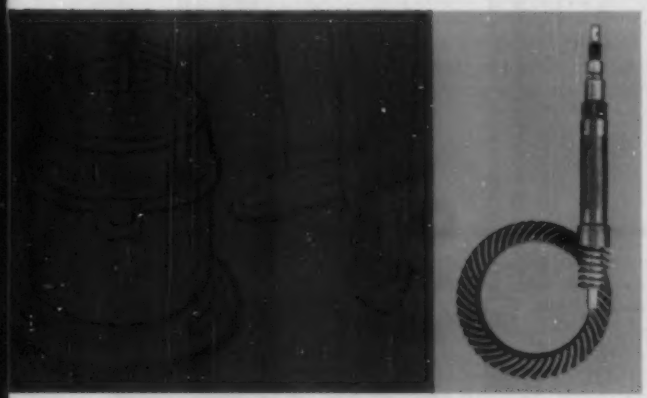
Fluid-flow Models Predict Design Performance, Aug 17 '59, p 64. Functional models that predict behavior of liquids flowing through or around obstructions.

Models Show How, Sep 16 '57, p 99. Full-color photos of typical models that help designers visualize a product.

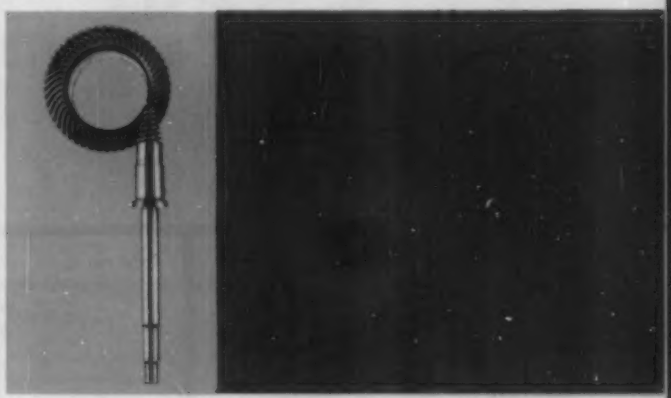
Short-run Stampings, Nov '55, p 174. How short-run stampings differ from usual long-run stampings; size, shape and material limitations; design tips for reducing per-piece cost.



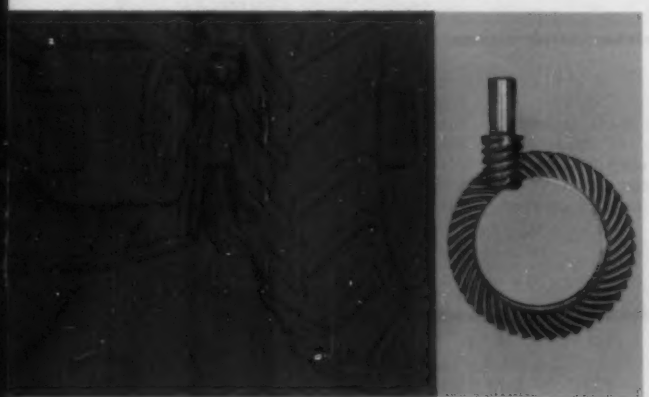
WHICH OF THESE HIGH-RATIO HYPOIDS IS "JUST RIGHT" FOR YOUR PRODUCT?



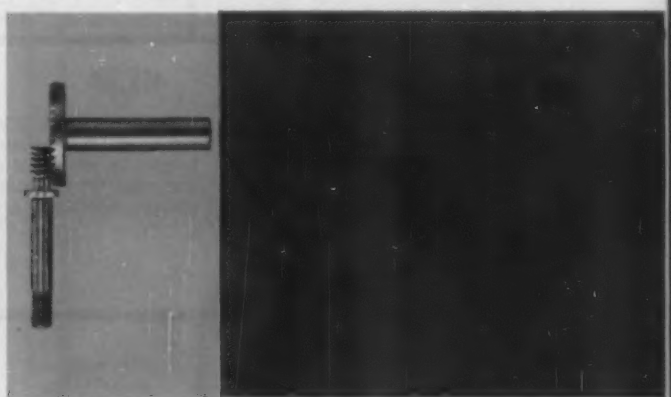
For hand tools. Where space is a problem—as in portable tools like this one—the high offset lets you design a more compact unit. Choose just the offset to solve your design problem with a more flexible, more compact unit than the corresponding worm and wheel.



. . . or machine tools. This high-offset pair lets you combine high reduction with strength, compactness and other advantages you might find profitable in designing machine tools. High-ratio hypoids can be produced on Gleason equipment for ratios of 1:10, 1:40 or even higher.



Big and strong. Where you need strength—as in farm machinery—high-offset hypoid pinions (with teeth which tend to "wrap around") are larger and stronger than corresponding bevel pinions. An extended shank on cylindrical pinions makes very rigid straddle mountings practical.



. . . or small and smooth. For smooth operation—as in office equipment that must run quietly—high-offset pairs provide smooth, quiet tooth action. Because teeth "wrap around" the pinion, you get continuous action—even with just one or two teeth! Grinders are available for applications requiring precision finish.

High-offset or high-ratio hypoids can be cut, tested, and quenched on the same Gleason equipment that is used on more familiar spiral bevel and hypoid gears. You can get more information about Gleason high-ratio hypoid gears by writing for free literature. Submit your prints for recommendations.

GLEASON WORKS

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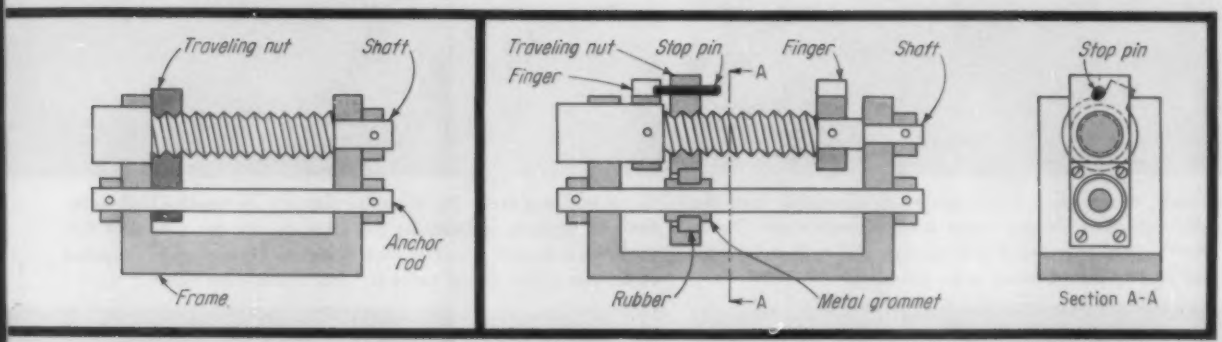
CIRCLE 69 ON READER SERVICE CARD

7 ways to LIMIT SHAFT

Traveling nuts, clutch plates, gear fingers, and pinned members are the bases of these ingenious mechanisms.

Mechanical stops are often required in automatic machinery and servomechanisms to limit shaft rotation to a given number of turns. Two problems to guard against, however, are: Excessive forces caused by abrupt stops; large torque requirements when rotation is reversed after being stopped.

I M ABELES, *design engineer, Ordnance Dept General Electric Co, Pittsfield, Mass*



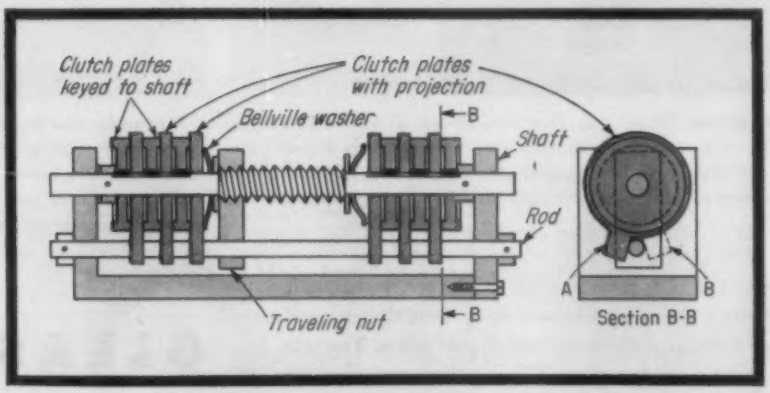
1

TRAVELING NUT moves (1) along threaded shaft until frame prevents further rotation. A simple device, but nut jams so tight that a large torque is required to move the shaft from its stopped position. This fault is overcome at the expense of increased length by providing a stop pin in the traveling nut (2). Engagement between pin and rotating finger must be shorter than the thread pitch so pin can clear finger on the first reverse-turn. The rubber ring and grommet lessen impact, provide a sliding surface. The grommet can be oil-impregnated metal.

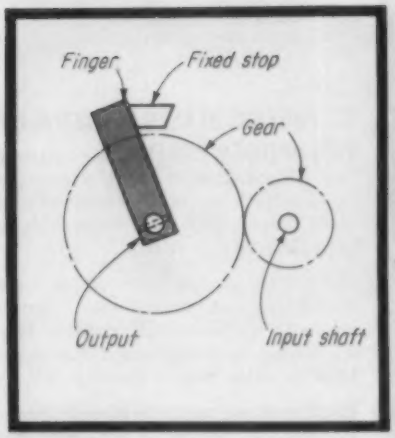
2

3

CLUTCH PLATES tighten and stop rotation as the rotating shaft moves the nut against the washer. When rotation is reversed, the clutch plates can turn with the shaft from A to B. During this movement comparatively low torque is required to free the nut from the clutch plates. Thereafter, subsequent movement is free of clutch friction until the action is repeated at other end of the shaft. Device is recommended for large torques because clutch plates absorb energy well.

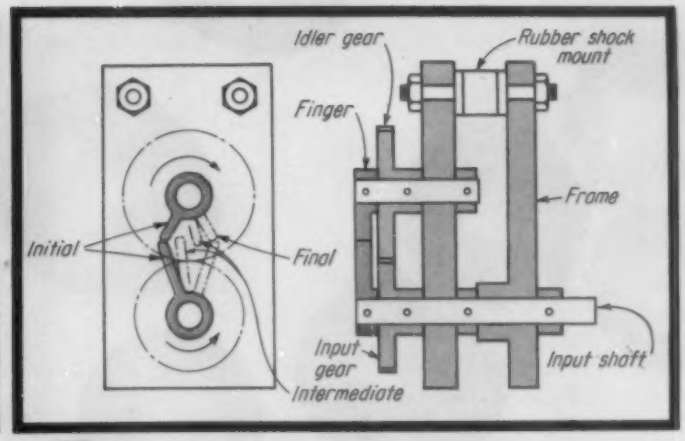


ROTATION



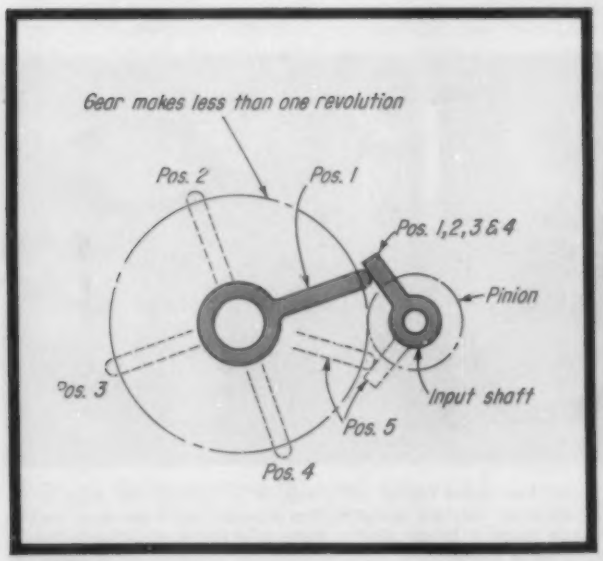
4

SHAFT FINGER on output shaft hits resilient stop after making less than one revolution. Force on stop depends upon gear ratio. Device is, therefore, limited to low ratios and few turns unless a worm-gear setup is used.



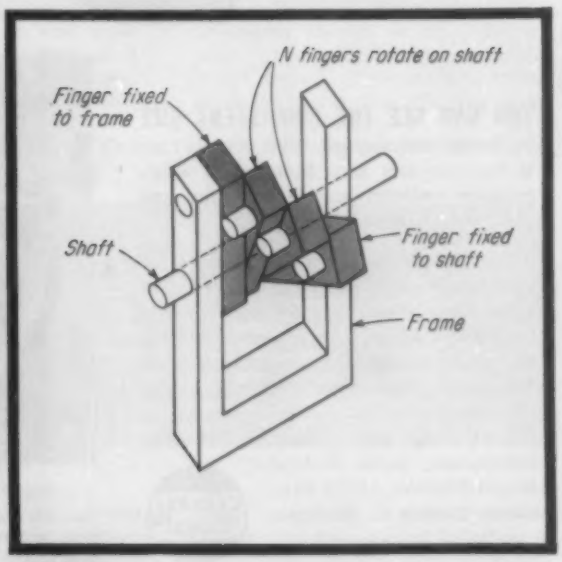
5

TWO FINGERS butt together at initial and final positions, prevent rotation beyond these limits. Rubber shock-mount absorbs impact load. Gear ratio of almost 1:1 ensures that fingers will be out of phase with one another until they meet on the final turn. Example: Gears with 30 to 32 teeth limit shaft rotation to 25 turns. Space is saved here but gears are costly.



6

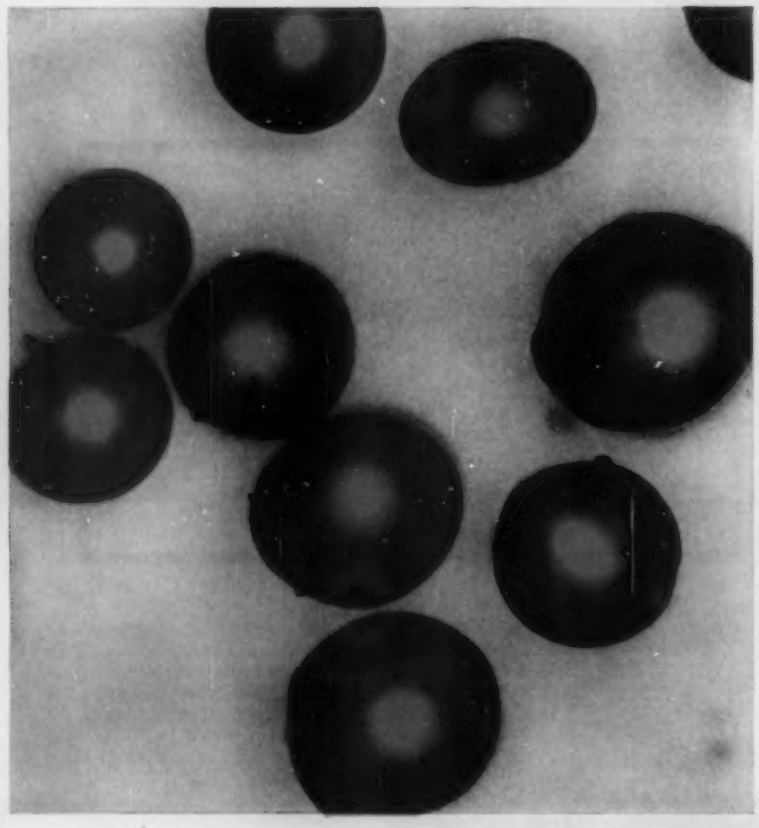
LARGE GEAR RATIO limits idler gear to less than one turn. Sometimes stop fingers can be added to already existing gears in a train, making this design simplest of all. Input gear, however, is limited to a maximum of about 5 turns.



7

PINNED FINGERS limit shaft turns to approximately N + 1 revolutions in either direction. Resilient pin-bushings would help reduce impact force.

30 MILLION OF THESE JET-FORMED SPHERES IN EVERY INCH OF BEARING SURFACE!



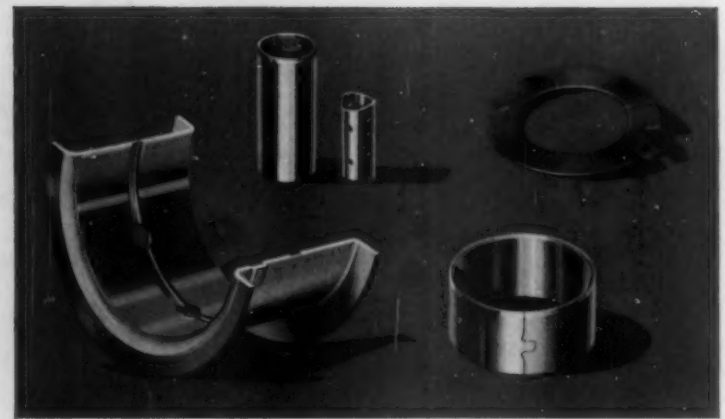
JET PROCESS BLASTS MOLTEN ALLOY INTO UNIFORM PARTICLES . . . so small that thirty million will form a thin layer only one inch square! This sintered layer is the bearing surface of Federal-Mogul sleeve bearings.

Molten copper-lead, alloyed to exact specifications, is poured into a special inert-atmosphere reaction crucible. Here it's blasted by a high-speed fluid jet to form the dense powder shown at left.

Because of the uniform particle size of this powder, the bearing surface of each F-M copper-lead sleeve bearing has precisely the same alloy composition and high adhesion to the steel backing as every other F-M bearing of the same alloy type!

YOU CAN SEE THE CONSISTENT SIZE in the photomicrograph. What you *can't* see is the consistent alloy composition which produces uniform bearing properties and performance in any alloy type.

Federal-Mogul makes engine bearings for every condition of speed and load. You can select from among five different sintered copper-lead alloys, all permanently bonded to precision-formed steel backing. Our Engineering Department is available to you for consultation or recommendations on bearing design and application. For more information, write Federal-Mogul Division, 11031 Shoemaker, Detroit 12, Michigan.



A COMPLETE LINE! Steel backed bearings with a selection of many different alloys for virtually any bearing application—Plain and bimetal bushings in bronze, steel or aluminum. Precision thrust washers in solid bronze, or sintered alloys on steel (one or both faces). Rolled split spacer tubes in steel, aluminum or stainless.

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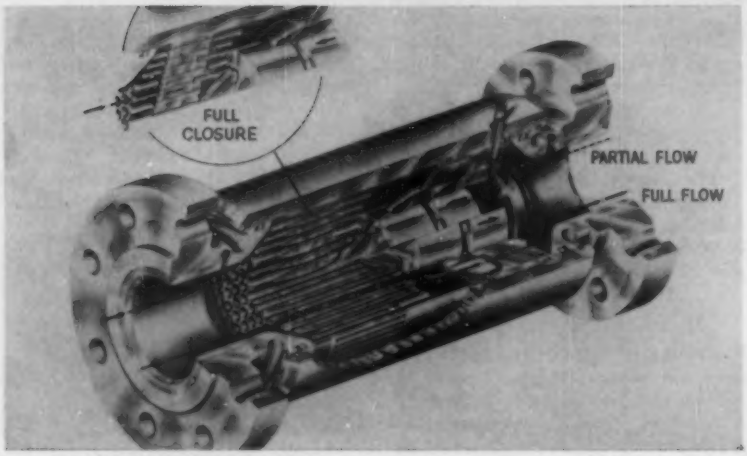
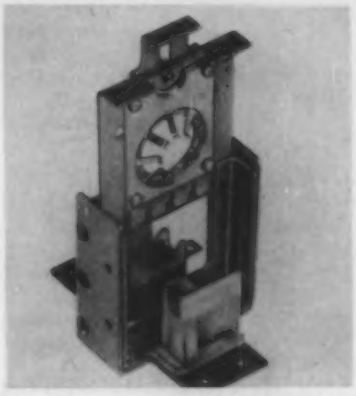
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES



Flexible, silent valve for fluid systems . . .
is said nearly to eliminate such undesirable physical phenomena associated with rapid flow of fluids as aeration, cavitation, surging, vibration and resultant noise. Valve is flexible in size and scope, and can be supplied in standard line sizes from 1 to 18 in. Heart of valve is cylindrical elastomer plug having a large number of axially aligned holes that serve as flow passages. Plug is contained in tubular housing between two perforated plates, one of which is either mechanically or hydraulically actuated to compress elastic insert. As plug is compressed, flow passages are reduced in diameter, thereby throttling fluid flow. At full compression, channels are closed for complete shutoff. Both cylindrical insert plug and valve body can be made of materials compatible with variety of fluids, including water and petroleum products. Max working pressure and wide-open flow coefficients depend on number of elastomer cartridges and diameter. Approximate net prices, FOB Azusa, for one unit, range from $3500 for 4-in., single-cartridge, standard, steel-body valve to $14,700 for 18 in. single-cartridge, standard, steel-body valve. Prices for multicartridge valves and valves with corrosion-resistant properties are slightly higher. Delivery time for one unit, within 90 days. **Aerojet-General Corp, Sub General Tire & Rubber Co, Azusa, Calif.**

Circle 300 on Reader Service Card



Guillotine-type tube socket . . .
achieves bandpass stability in UHF, lumped-constant circuitry as tubes are changed. Miniature tube socket, which seats positively, can be used to 1000 mc or higher with no resonance over band. Primarily intended for grounded-grid service, it provides min inductance for grid-return path to ground. Ground plane isolates input and output for amplifier stability. Eliminates poor grounding and high-contact inductance, which limit upper operating frequency, as well as varying circuit values resulting from shift of contacts or circuit parts and poor seating. Withstands vibration of 10 to 55 cps, $\frac{1}{16}$ in. excursion. Price ranges from $25 to $14, depending upon quantity. **Instruments for Industry Inc, 101 New South Rd, Hicksville, NY.**

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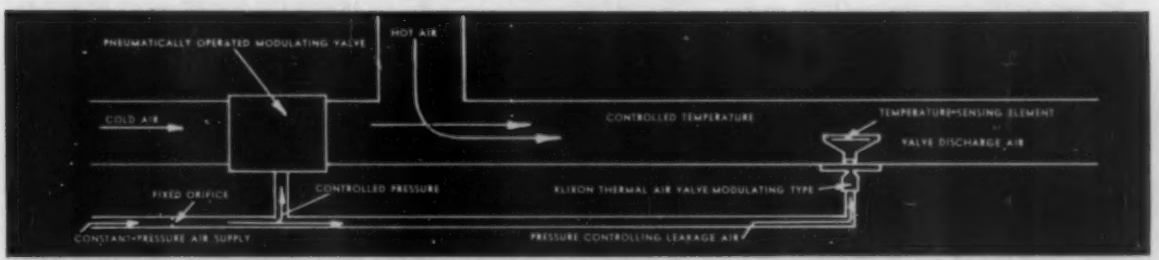

Bimetal disk-actuated thermal valves . . .
can be, depending upon configuration, either snap-acting for instantaneous control of media flow, or modulating for graduated control within a fixed temperature range (see schematic of typical application). Over-center force, inherent in bimetal disk, mechanically opens or closes an orifice directly rather than making or breaking an electrical circuit. Thermal valves, suitable for pilot or control use, are said to be completely immersible, with high resistance to corrosion, shock and vibration. As servo valves, they cause main control valve to open or close on signal in response to temperature and/or pressure changes. Ambient setting of −65 to 500 F are available. Parts are reported to provide tight seals, holding leakage to as low as 0.5 cc per min. **Spencer Products Group, Metals & Controls Div, Texas Instruments Inc, Attleboro, Mass.**

Circle 302 on Reader Service Card

Heat-treated aluminum sheet

in 6060, 2024 and 7075 high-strength alloys, is available either bare or clad with thin outer layers of specially formulated, corrosion-resistant aluminum that is metallurgically bonded to the core. Alloying and heat treatment can provide yield strength of 76,000 psi max. Variety of gages, sizes and tempers. **Olin Mathieson Chemical Corp, 460 Park Ave, New York 22.**

Circle 303 on Reader Service Card

Five terminal styles . . .

are now offered on subminiature, precision, snap-acting switches. Styles include three kinds of solder-lug terminals, as well as snap-on terminals and terminals for printed-circuit wiring, designed to fit ⅛-in. slots in wiring boards. **Unimax Switch Div, W L Maxson Corp, Ives Rd, Wallingford, Conn.**

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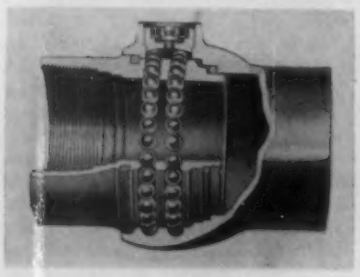


Stainless swing joints . . .

for bulk loading or unloading of fluids, chemicals or other corrosive products. Available with spring-balanced, ball-bearing action in 2½-, 3- and 4-in. sizes or counter-balanced action in 2-, 2½-, 3- and 4-in. sizes. Spring-balanced units are $1305, $1378 and $1904, respectively. Counter-balanced types are $880, $1276, $1348 and $1908, respectively. **OPW-Jordon Corp, 6013 Wiehe Rd, Cincinnati.**

Circle 305 on Reader Service Card

Unsupported, calendered tape

for sandwich construction and metal-to-metal bonding, supplied in rolls 18 in. wide, can be cut and trimmed to shape of areas to be bonded. At room temperature, adhesive is dry and pliable; at elevated temperatures, it momentarily softens and flows, wetting bonding surfaces. With continued application of heat and moderate pressure, adhesive cures into tough, high-strength film capable of maintaining bond strength at up to 200 F. As normally supplied, adhesive weighs approximately 0.050 lb per sq ft and produces bond line of about 0.005 in. after cure under vacuum-bag pressure. In metal-to-metal bonds, room-temperature shear strengths range from 5000 to 6000 psi. **Narmco Resins & Coatings Co, 600 Victoria St, Costa Mesa, Calif.**

Circle 306 on Reader Service Card

Epoxy coating air-dries . . .

in a few minutes to provide protective or decorative finish for metals, without sacrificing durability imparted by baking. Epoxy acrylic is offered in range of colors and in any degree of gloss from zero to 95. Flexibility is reported to be excellent. Coating, it is said, does not discolor when subjected to sun; resists such elements as salt, fog, humidity, acid and alkalis. **Industrial Finishes Co, 1119 Land Title Bldg, Broad and Chestnut Sts, Philadelphia 10.**

Circle 307 on Reader Service Card

Modular temperature-scanner

scans and monitors up to 50 points by utilizing modular assemblies of temperature-sensitive elements. Modules consist of relays and potentiometers mounted on plug-in base. New points may be added by plugging in a module and connecting sensor leads. No critical circuits are interrupted if module is removed. Each module may have a different temperature limit. Can be arranged to read each point successively from 1 to 50 or to monitor continuously any one selected point, from 1 to 50. Sounds alarm and lights module light if selected point or points exceed limit. Scanning rate is said to be variable. **Tipptronic Inc, 510 E Washington St, Chagrin Falls, Ohio.**

Circle 308 on Reader Service Card

Silicone dielectric greases . . .

are reported to maintain their consistency from —65 to 400 F. As a result, they suit applications where conventional greases would either solidify or be subject to oxidation, evaporation and excessive bleed losses. One grease is formulated to minimize oxidation of copper conductors and is suitable insulating material for use around copper wire and splices. Another is available for general-purpose electrical applications. Both are soft, workable, silicone greases that are chemically inert and can be used over a broad PH range. **Silicone Products Dept, General Electric Co, Waterford, NY.**

Circle 309 on Reader Service Card

Low-cost, on-off control valve

for clamp-type and other single-acting, spring-return air cylinders is especially suitable for use in tight places. Compact design permits use in line, on cylinder or on machine in multiple applications. **Foster Mfg Co, St Louis 18.**

Circle 310 on Reader Service Card

Magnetic-readout digital encoder . . .

has 13-bit binary output. Can be operated with no adverse effects in any environment, at speeds to 10,000 rpm and with any number of readouts. Only passive circuitry is involved in readout. Parallel output is in binary code and total count is reached with 64 turns of input shaft. Lead-lag head arrangements permit min external-decision circuitry. **Ascop, Div Electro-Mechanical Research Inc, PO Box 44, Princeton, NJ.**

Circle 311 on Reader Service Card

Sampling valve . . .

extracts samples at midstream for contamination-particle counts in fuels and hydraulic fluids without disrupting flow or pressure. Valve is said to be compact, lightweight, inexpensive and able to replace several pieces of hardware, such as needle valves and tees. **Industrial Measurements Sales Inc, 445 N Garey Ave, Pomona, Calif.**

Circle 312 on Reader Service Card

Medium-duty, pressed-steel pulley . . .

has rolled-steel flange that locks in groove angle; hub that is multi-swaged to rim for high torque strength; wider wheel spokes with deep embossments for added strength; wider surface area contact in welding area to make groove stronger and prevent it from flexing. Available in range of sizes and prices. **Barke Products Inc, 501 Vineland Dr, Bay Village, Ohio.**

Circle 313 on Reader Service Card

Variable-frequency generator

is miniature permanent-magnet-type generator that provides two-phase ac output. Voltage, amplitude and frequency vary in direct proportion to shaft speed. It is used as a reference generator to provide information on rotational speed and angular position of a shaft, as in constant-velocity servo systems. In size 11 case, weighs 2.5 oz. Offers driving torque of 0.005 in.-oz max at 3000 rpm under rated load. Provides 8 v rms at 3600 rpm into balanced 10,000-ohm load. Useful range is 0 to 15,000 rpm. Operates in —67 to

(continued on page 77)

CIRCLE 75 ON READER SERVICE CARD→

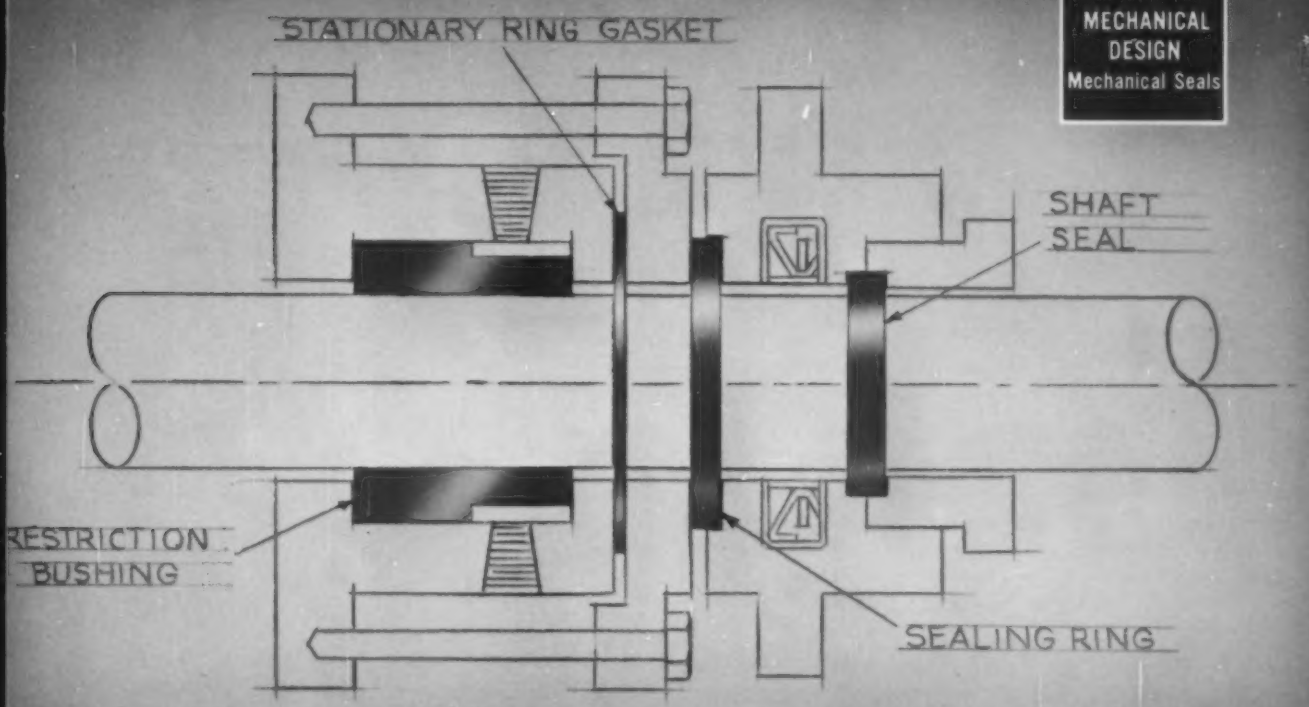
DU PONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

Number M-7
in a series
MECHANICAL
DESIGN
Mechanical Seals



Here's how TFE resins improve your mechanical seals

The unique properties of TFE fluorocarbon resins as sealing materials are particularly pertinent to the design of mechanical seals. The reasons for the growing and widespread acceptance of mechanical seals as pump seals, agitator seals, motor seals and seals on many other types of moving machinery are exactly the same reasons that TFE resins are being used at the heart of the mechanical seal.

The advantages of mechanical seals include savings in both materials and labor for repacking and packing adjustment. They eliminate wear on the shaft. They greatly reduce leakage and eliminate loss of product. They enhance safety in the handling of toxic or flammable materials.

The advantages of TFE resins in mechanical seals include savings in replacement and maintenance costs because of their long life and interchangeability in being able to handle almost all chemicals. Their natural lubricity and ability to embed hard foreign particles without damage greatly reduce shaft wear. They produce tight, lasting seals to eliminate leakage. TFE resins are completely inert to virtually all chemicals and solvents, and they maintain their superior properties under a wide temperature range.

On the following page you will see how TFE resins in the individual components of mechanical seals supplement or add to the ability of these seals to do their job in industry. When selecting a mechanical seal, it is worthwhile to remember these points.

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

OVER

Where TEFLON TFE resins are used in mechanical seals

All mechanical seals retain the principle of two mating surfaces at right angles to the shaft. The one driven with the shaft is called the sealing ring; the other, attached to the casing, is called the gland ring. To keep the mating surfaces in contact, one or more springs may be made to bear on the movable sealing ring, or a flexible bellows or diaphragm may provide at least part of the desired spring action. Sealing of the movable ring to the shaft may be by use of a diaphragm or bellows; more commonly, the sealing ring is packed to the shaft by some form of flexible, non-metallic packing such as an O-ring, V-ring or wedge-type seal. The stationary ring is commonly sealed by means of a flexible gasket.

SHAFT SEALING

The shaft packing, a sliding seal application, makes excellent use of TEFLON TFE resins, whose chemical inertness and heat resistance make them the preferred seal material. The tremendous flex life of TFE resins also makes them excellent materials for the bellows type of shaft seal.

SEALING RING

Wear noses of compounded TEFLON TFE resins have answered the problem of extreme corrosion resistance. They will not embrittle, are easy to handle and install. Their low friction, combined with their high and low temperature properties, contributes to this application. TEFLON TFE resins have the lowest coefficient of friction of any solid material, including graphite and molysulfide. Their static coefficient of friction is even lower than the dynamic value (as low as 0.016)—completely eliminating problems of stick-slip.

STATIONARY RING GASKET

The stationary ring is frequently seated by a retaining flange with gaskets. Since TEFLON TFE resins are superior gasket materials, they have found wide acceptance in this use. In addition, TFE resins are often specified because of their interchangeability, minimizing spare-part storage.

RESTRICTION BUSHINGS

Restriction bushings are widely used with seals that are flushed to achieve cooler operation or to prevent abrasives from entering the seal. Because of their wide range of excellent properties, TEFLON TFE resins have almost become standard for this application. Aside from their chemical and thermal properties, their low-frictional characteristic means that as shaft run-out becomes a problem, the resin will not score the shaft. In addition, the anti-stick property of TFE resins prevents scale from building up on the surface.

FOR MORE INFORMATION...

Further details on the properties and design characteristics of TFE resins for use in mechanical seals may be obtained from your local supplier. Look for him under "Plastics—Du Pont" in the Yellow Pages. Or write to: E. I. du Pont de Nemours & Co. (Inc.), Advertising Department, Room T-36160, Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Quebec.

DU PONT REG. U.S. PAT. OFF. TEFLON®

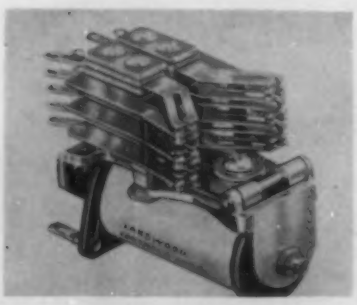
TFE-FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

257 F. Cedar Engineering, Div Control Data Corp, 5806 W 36th St, Minneapolis.
Circle 314 on Reader Service Card

Temperature controller . . . has all circuitry, except tubes and relay, encapsulated in epoxy. Furnished with anticipating section for control stability of ±1 F. Comes with load relay rated at 25 amp, 230 v. Standard ranges of 200 to 600 F and 0 to 200 F are available. List price is $106, complete with anticipating section, thermistor sensing element, load relay and enclosure. Electronic Processes Corp of Calif, 436 Bryant St, San Francisco 7.
Circle 315 on Reader Service Card

Two-terminal lampholder . . . for use with both neon and incandescent bulbs, mounts in ⅞-in. hole. Front-removable, two-terminal, subminiature lampholder eliminates need for two different sizes and shapes in same panel. Has midget flange base and is available with lenses of red, white, blue, green, clear and amber. Sloan Co, 4209 Burbank Blvd, Burbank, Calif.
Circle 316 on Reader Service Card



Telephone-type relay . . . uses twin contacts that operate independently of each other, assuring that one will close even if other is blocked. Pivot pin turns in cylinder of different metal, which is full width of the heel piece. Twin contact points of palladium have combined rated current-carrying capacity of 4 amp, 150 w. Operating speed is 1 to 2 millisec minimum. Lakewood Controls Corp, Industrial Rd, Crystal Lake, Ill.
Circle 317 on Reader Service Card

Wiring devices that resist . . . corrosion, oils, greases and most acids include two- and three-wire caps, connectors, receptacles and grounding lines. UL-approved. Chem Marine Dept, Harvey Hubbell Inc, Bridgeport 2, Conn.
Circle 318 on Reader Service Card

(continued on page 81)

Chace
THERMOSTATIC BIMETAL
Actuates Another Precision Product
THE WESTINGHOUSE ELECTRIC BLANKET CONTROL

A PRODUCT OF
WESTINGHOUSE ELECTRIC CORPORATION
MANSFIELD, OHIO

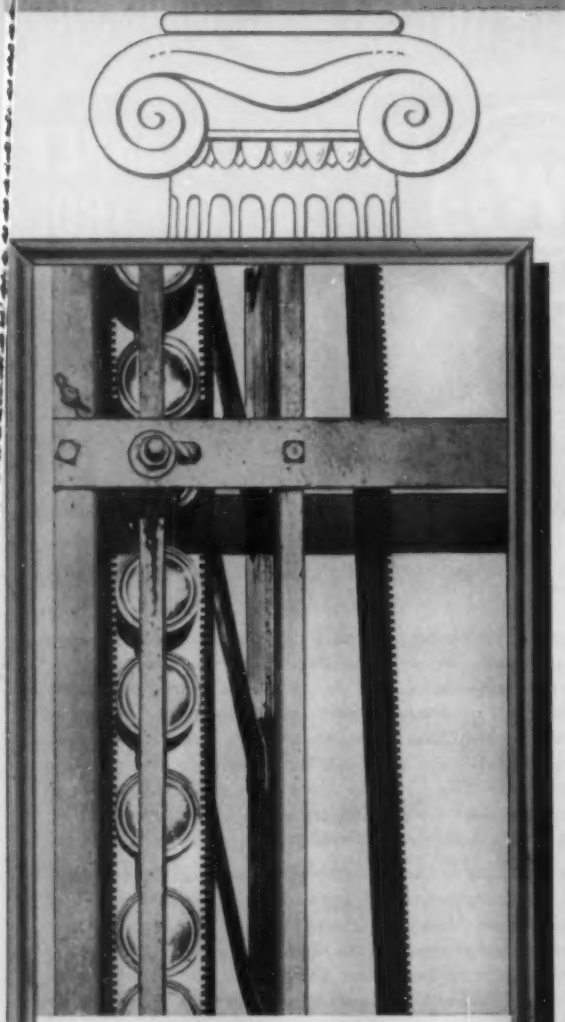
This new control for the Westinghouse "Aristocrat" Electric Blanket provides cozy, gentle warmth regardless of weather conditions or changes in room temperature. You simply set the Control Dial to the warmth desired and the blanket automatically maintains the comfort range selected, all night long. Twin, double with single or dual controls, or King size types are available. The signal light is a reminder that the Control is on. The protective thermostats are actuated by nine Chace bimetal elements for positive protection against overheating. They are accurately calibrated and sealed against moisture.

Chace is always eager to accept the burden of proof of the quality of the thermostatic bimetal we manufacture and we suggest that millions of reliable appliances working day and night without care or worry are the soundest kind of proof. In this instance, we assume a multiple responsibility as each position on the Control Dial is really a separate thermostat in itself, hence the necessity for precision and dependability is multiplied. Chace customers through the years have learned that their precision products can be sent out safely to their buyers in industry and the home when Chace furnishes the actuating bimetal; and new manufacturers who look at our record of a third of a century of development and production of precision thermostatic bimetal exclusively soon acquire a similar confidence in Chace.

When *your* new temperature-actuated device approaches the design stage, send for our booklet, "Successful Applications of Chace Thermostatic Bimetal", containing valuable engineering information. Remember, too, that over 30 types of Chace Thermostatic Bimetal are available in strip, coils or completely fabricated elements of customer's designs.

IT BENDS WITH THE HEAT
W. M. CHACE CO.
Thermostatic Bimetal
1607 BEARD AVE., DETROIT 9, MICH.

HAULS OF



Hoisting Millions of Beers
—straight up—with never a slip

At the giant Anheuser-Busch brewery, this pair of U.S. SteepGrade Conveyor Belts lifts 16-oz. cans of beer *at a 90-degree angle.*

"No other belt could have accomplished better performance. It's nothing short of spectacular," says the manager of the brewery.

As the 1-lb. cans come from the pasteurizer slippery and wet, they roll onto the vertical can conveyor where SteepGrade carries them straight up and onto an incline to the carton-filling machine. Cans don't slip at all, even when the conveyor is stopped.

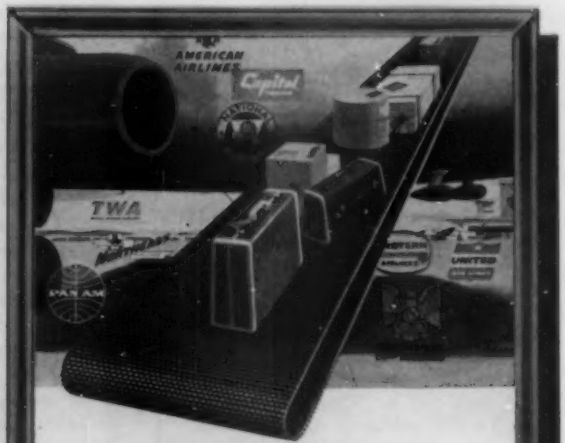
The secret is SteepGrade's exclusive "gripper cleat" construction—a molded, integral part of the belt itself. These thousands of "gripper cleats" hold the cans firmly, yet gently. This means far less pressure, far less belt speed is required. Damage to cans and print smearing is eliminated. And the more efficient operation saves electric power, lengthens belt life.

HERE are on-the-job stories of three United States Rubber Conveyor Belts, taken from "U.S." belt records in package handling.

These belts are just some of the "U.S." stand-outs which demonstrate, year after year, why "U.S." is the world's largest producer of conveyor belts.

For steady, day-in-and-day-out dependability in conveyor belting, it always pays you to secure the advantages of "U.S." Engineering. "U.S." Engineers work directly with "U.S." Distributors or original equipment manufacturers to assure their obtaining the right belt recommendations for each type of conveying.

The most comprehensive belting engineering information in the industry is available through your "U.S." Distributor. It will pay you to check with him.

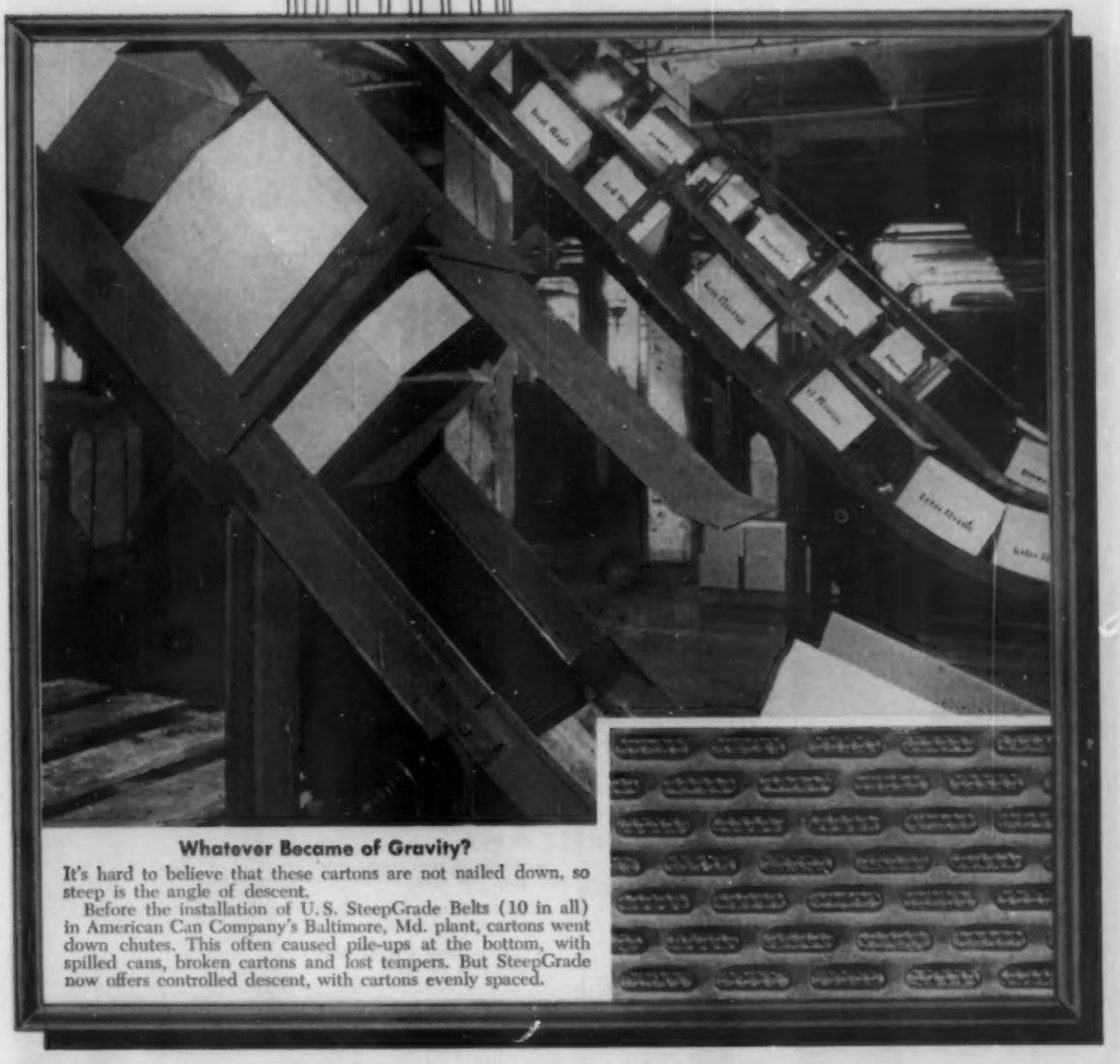


U.S. STEEPGRADE,
serving the world's great airlines

Next time you're at an airport chances are you'll be able to see U.S. SteepGrade Conveyor Belting in action. You'll see it carrying cargoes on steep inclines and declines—as steep as 45 degrees. It speeds up loading, reduces manual labor for today's leading airlines.

Again notice the gripper cleats in SteepGrade. They cannot be torn off by heavy boxes. SteepGrade is weather resistant, will not stiffen in extremely low temperatures and is self-cleaning.

FAME



Whatever Became of Gravity?

It's hard to believe that these cartons are not nailed down, so steep is the angle of descent.

Before the installation of U. S. SteepGrade Belts (10 in all) in American Can Company's Baltimore, Md. plant, cartons went down chutes. This often caused pile-ups at the bottom, with spilled cans, broken cartons and lost tempers. But SteepGrade now offers controlled descent, with cartons evenly spaced.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

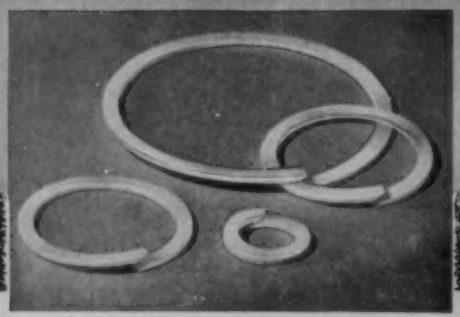
CIRCLE 79 ON READER SERVICE CARD

PRECISION

H·I·S TEFLON*

for LIFE-TIME & TROUBLE-FREE

HYDRAULIC SERVICE

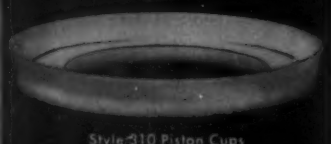


Single Turn Back-up RINGS . . .

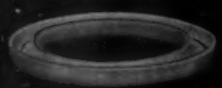
ALL THE NEW MILITARY SIZES — MS-28774, MS-28777 and MS-9058.

Accurately machined to assure you the fullest utility range and life of your equipment.

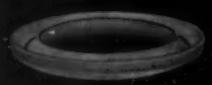
Only **HALOGEN** *offers* **"MEMORIZED" TEFLON**



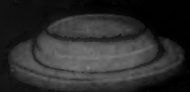
Style 310 Piston Cups



Style 614 V Rings



Style 410 U Cups and Blocked Vees



Style 210 Flange Seals

Halogen cylinder packing is known for operating successfully and efficiently over the widest temperature and pressure ranges . . . because they are "MEMORIZED".

This is an EXCLUSIVE process which makes the packing lip "remember" the size of the rod or cylinder . . . and keeps it in sealing position, regardless of temperature variations.

Send your prints for assembly details and find out about FIELD PROVEN AND ENGINEERED "TEFLON by HALOGEN."

Write for complete catalog on "TEFLON HYDRAULIC SEALS" . . . it's FREE!

HALOGEN

INSULATOR & SEAL CORP.

9960 Pacific Avenue, Franklin Park, Illinois, Gladstone 5-9000

Engineers and manufacturers of products of TEFLON *DuPont T.M.

SPEED PRODUCTION and LOWER COST on your products with this

GRIP-NUT

family of

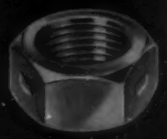
GRIPCO FASTENERS

All types and sizes of Gripco fasteners listed in catalogue are available for immediate delivery.

Qualified fastener engineers are available for consultation on all your assembly problems.

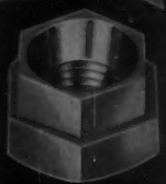
GRIPCO LOCK NUT

One piece all metal.



GRIPCO CENTERLOCK NUT

Locking feature in the center for fast feeding. Can be applied from either end.



GRIPCO CLINCH NUT

With or without Gripco-Lock. For application to metal too thin to thread or for inaccessible assemblies. Hex collar prevents turning when torqueing bolt.

GRIPCO PILOT-PROJECTION WELD NUT

With or without Gripco Lock. Centering collar positions nut and protects threads from weld spatter.

GRIPCO COUNTERSUNK WELD NUT

With or without Gripco Lock. Countersink protects threads from weld spatter.

Other Gripco Products:

- BRASS GRIPCO OR CENTERLOCK NUTS.
- MINIATURE WELD AND CLINCH NUTS, WITH OR WITHOUT LOCK.
- GRIPCO AND CENTERLOCK HI NUTS.
- STANDARD SEMI-FINISH FULL AND JAM NUTS.
- STAINLESS STEEL LOCK, WELD AND SEMI-FINISH NUTS.
- COLD FORMED SPECIAL NUTS OR PARTS TO PRINT.

The Nation's Oldest Manufacturer of Lock Nuts

Send for samples and NEW CATALOG today

GRIP-NUT COMPANY

102 MAPLE AVE. ★ SOUTH WHITLEY, INDIANA

Hand-held vaporizing spray gun . . .

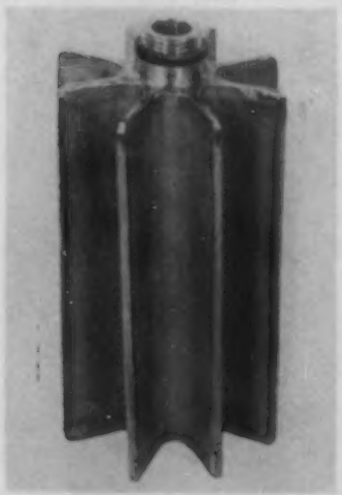
weighs less than 4 lb and measures 3½ in. long. Operates on gases, such as argon and nitrogen, at power levels to 40 kw. Device is said to extend range and capabilities of materials-engineering into refractory metals, carbides, borides, silicides and nitrides. Most materials can be spray-coated on steel, molybdenum, niobium, aluminum, magnesium and many plastics. Controlled spray-coatings allow matching of thermal coefficients of expansion with thermal conductivities of coatings and base materials. Hand-spray systems range from $6240 to $8955. Standard delivery, 60 to 90 days. **Giannini Plasmadyne Corp, 8339 S Main St, Santa Ana, Calif.**

Circle 319 on Reader Service Card

Flame-retardant laminate . . .

is paper-base, Grade-X laminate with special phenolic resin. Sheets, ⅛ and ¼ in. thick, offer flexural strength, flatwise and lengthwise, of 25,000 psi min; tensile strength, lengthwise, of 20,000 psi min. Operates in temperatures of 225 to 250 F max on continuous basis; 250 to 275 F max on intermittent basis. Offered in sheets about 49 x 49 in., in thicknesses from 1/32 to 1 in. inclusive. **Taylor Fibre Co, Norristown, Penna.**

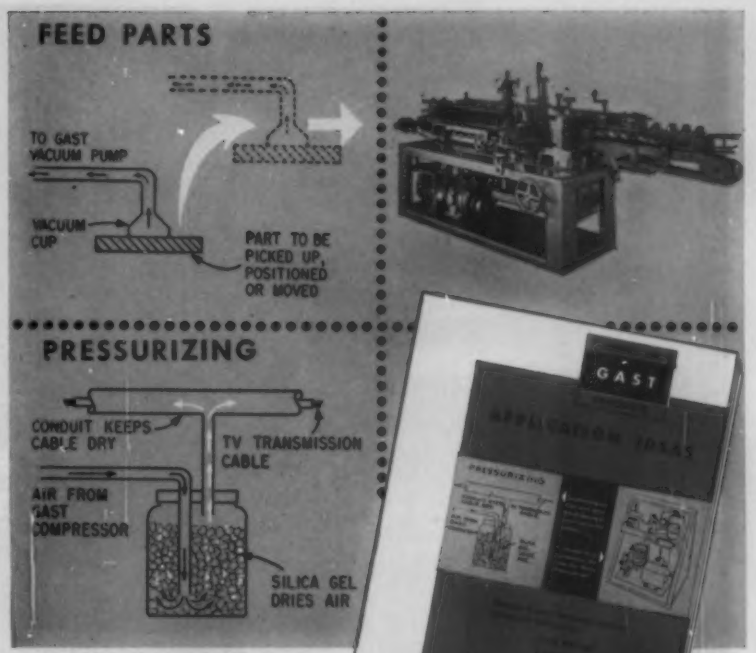
Circle 320 on Reader Service Card



Small-size filter . . .

has high flow rate and large cake capacity. Porous, stainless steel filter element in 4-in.-dia housing is available in lengths from 6 to 18 in. Filtration ratings down to 2 microns are offered. Suitable for operating pressures from full vacuum to 125 psi and temperatures to 300 F. Large surface area per unit volume permits, for

(continued on page 85)



NEW

Gast Booklet ready to give you

"APPLICATION IDEAS"

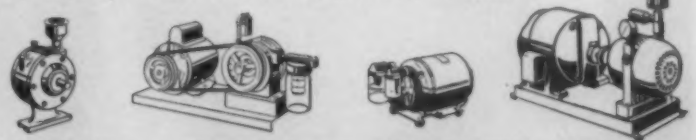
for air motors, compressors, vacuum pumps

Looking for new ways to improve methods—save time—or cut costs? This booklet may be valuable to you! With line drawings, it shows dozens of the basic principles of "putting air to work".

With photographs of our customers' products—from air mixers to data plotters—it illustrates each principle ... and shows how Gast rotary Air Motors, Compressors and Vacuum Pumps provide advantages as original equipment or in plant use.

Design Engineer or Plant Master Mechanic, you'll find this booklet of interest ... and it may "spark" an important idea you can use!

Write today for NEW "APPLICATION IDEAS" Booklet!



ROTARY AIR MOTORS 6 sizes, 1/20 to 7 h.p. | VACUUM PUMPS TO 28", ½ to 48 c.f.m. | INTEGRAL-MOTOR PUMPS Both vac. and pressure | AIR COMPRESSORS to 30 p.s.i., ½ to 43 c.f.m.

GAST MANUFACTURING CORP., P.O. Box 117-V, Benton Harbor, Michigan

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE OR FLUID POWER DIRECTORY

GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

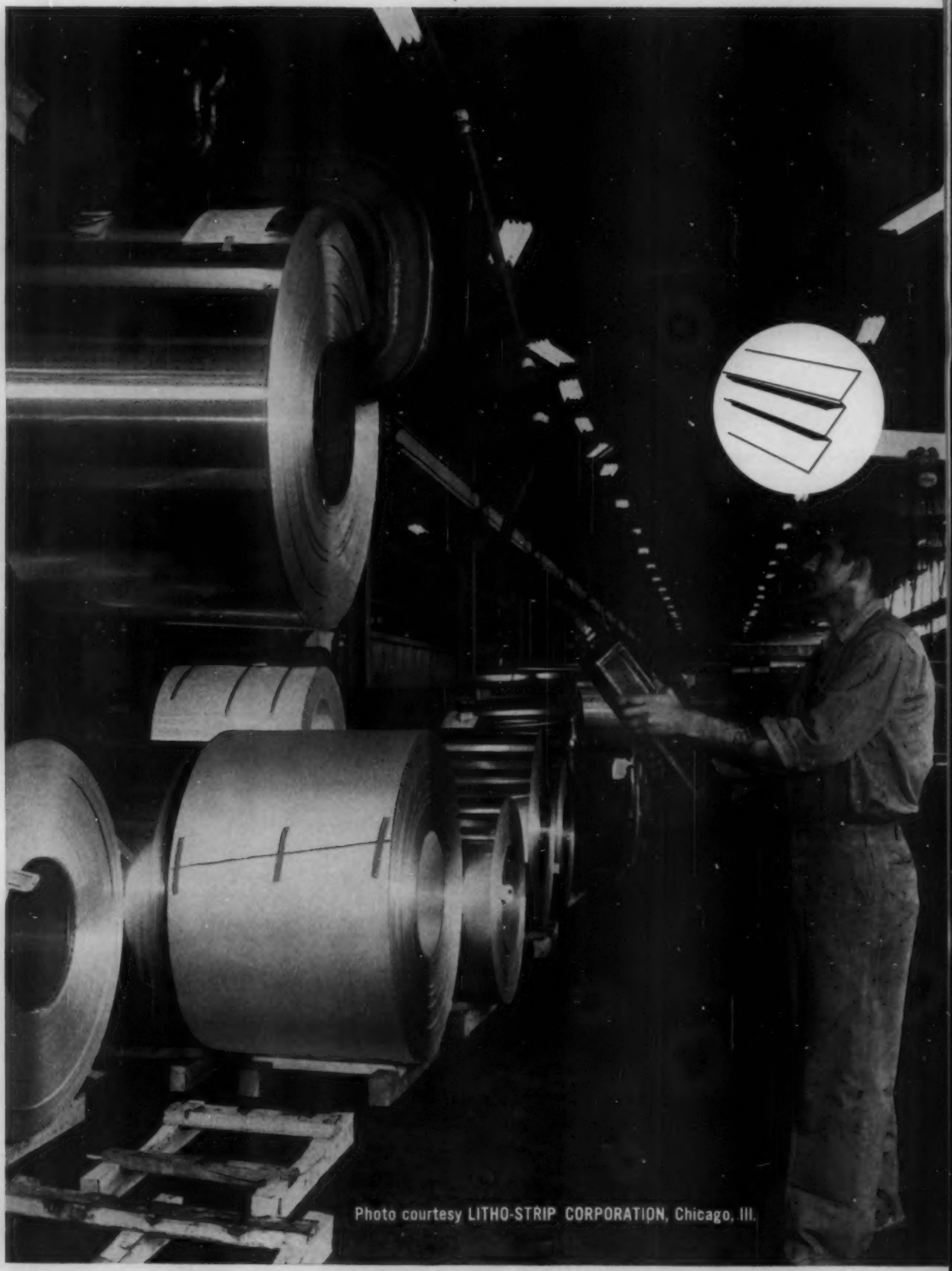
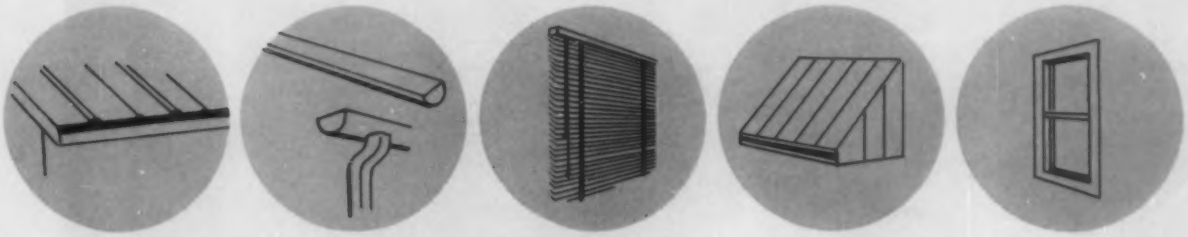


Photo courtesy LITHO-STRIP CORPORATION, Chicago, Ill.

BONDERIZED ALUMINUM

makes your painted products look better longer



Most famous of all surface treatments for metals—BONDERITE—makes painted aluminum look better longer.

Bonderite on aluminum means fine appearance longer, because it controls corrosion and anchors the paint.

Bonderized and painted aluminum is produced on automated strip lines in which the metal is cleaned, Bonderized and painted, then re-coiled ready for use.

Stamped or roll-formed products are made from pre-painted, Bonderized aluminum coil without loss of paint adhesion, even from the most severe deformation. Here's production efficiency and economy at its best—better products at less cost.

Many Applications of Bonderite for Aluminum

There's more than one type of Bonderite for use on aluminum. In wide use is Bonderite as a base for paint, which adds durability and long life to paint finishes on so many aluminum products.

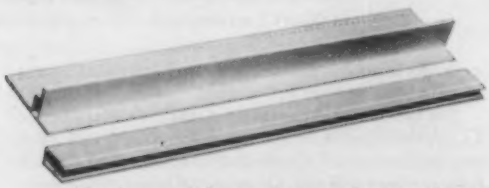
Another Bonderite produces an attractive green coating, used on many architectural products without further finish.

Protection without changing the characteristic color of the metal is provided by another Bonderite.

There is also a Bonderite, formulated for mixed production, which coats aluminum, steel and zinc.

Bonderite for aluminum meets and exceeds the requirements of Government Specification MIL-C-5541.

Well over two hundred plants—large, medium-sized and small—use these great Parker products on their aluminum production. Better investigate for *your* plant, today!



Aluminum window and screen frame sections Bonderized, painted and formed after painting. No breaks in finish anywhere! (Courtesy, Security Co., Detroit, Mich.)

SEND FOR ILLUSTRATED BULLETIN!—*Free bulletin, with more complete information and details, mailed immediately upon request. Ask for Bulletin A6790, "Bonderite for Aluminum."*

Parker Rust Proof Company

2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE corrosion resistant paint base	BONDERITE and BONDERLUBE aids in cold forming of metals	PARCO COMPOUND rust resistant	PARCO LUBRITE—wear resistant for friction surfaces	TROPICAL—heavy duty maintenance paints since 1883

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

From Honeywell

A compact inexpensive controller

- **Automatic temperature control**
- **Automatic pressure control**
- **Automatic control of liquid level**
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Exclusive Honeywell Versa-Tran replaces old fashioned mechanical control *at low cost.*

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example, the 6-in. unit to be used for flow rates to 5 gpm or 60 cfm at pressure drops of 2 to 3 psi. **Micro Metallic Div, Pall Corp, 30 Sea Cliff Ave, Glen Cove, NY.**

Circle 321 on Reader Service Card

Laminated-plastic bearings . . . can be run dry. Successful use of these Teflon 180°-segment bearings in heat to 275 F has been reported. **Industrial Plastic Supply Div, Industrial Safety Supply Co Inc, 574 New Park Ave, W Hartford 10, Conn.**

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Shock-testing machine . . . accommodates test specimens that weigh up to 20 lb and occupy an 8-in. cube. Said to provide accurate and repeatable half-sine, saw-tooth and square waves. Same pulse is reported to be reproducible in repeated tests and from one machine to another. Requires 110 v power source. May be operated manually or automatically for any specified shock pulse. Shipped fully assembled. Stands 7 ft 3 in. high; occupies 12 x 16 in. **Barry Controls Inc, 700 Pleasant St, Watertown, Mass.**

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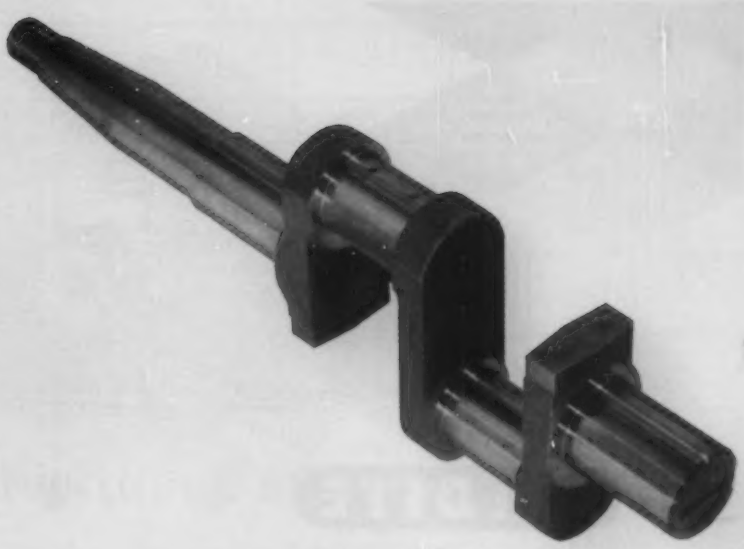

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A CASE IN POINT—This seventy pound ductile iron crankshaft is made for compressors manufactured by The Brunner Division of Dunham-Bush, Inc. The increased loads and speeds called for by new compressor design specifications required rigidity and strength beyond the limits of the cast iron alloy shafts formerly used. Ductile iron was chosen because the rigidity, tensile strength, fatigue strength and wear characteristics comfortably exceed operating requirements. A major bonus—the existing pattern equipment could be used for the ductile iron castings, thus saving the high cost of dies needed for steel forgings.

Ductile iron has most of the engineering advantages of steel yet it can be designed with the same flexibility and cast with the same procedures as gray iron. The 120-90-02 grade used in this case has an elastic modulus of about 24 x 10^6 psi, 42,000 psi endurance limit, and 300 BHN. The 120,000 psi tensile strength is double that of the previous crankshaft. Hamilton Foundry regularly casts all grades of ductile iron and high alloy Ductile Ni-Resist.

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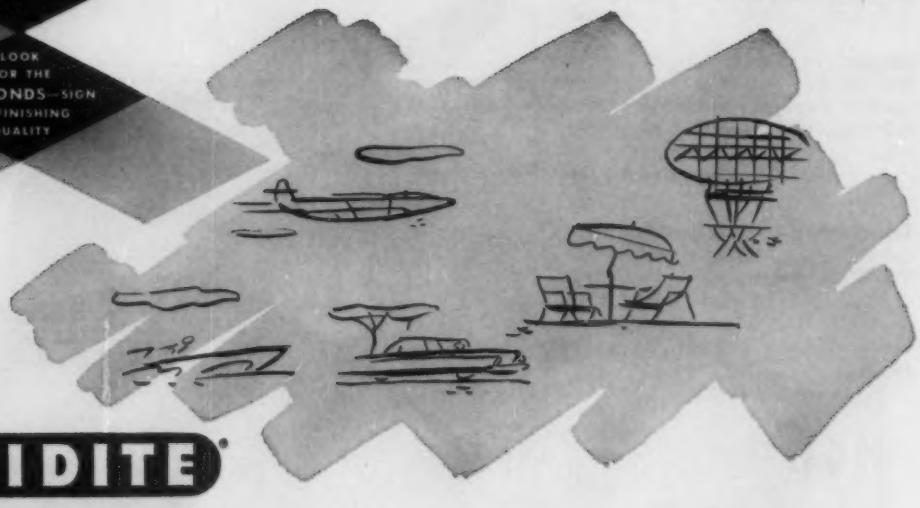

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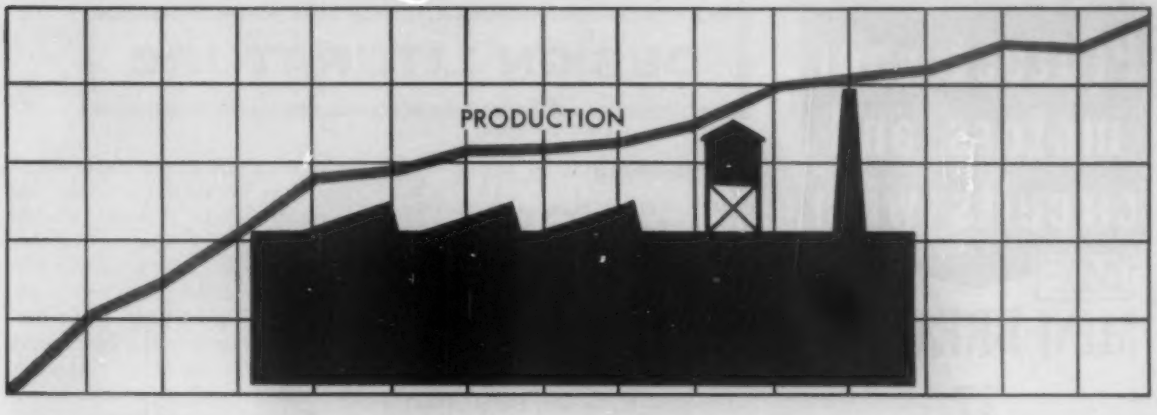

How to expand without added expenditure

Right away let's make this point clear: you won't find any magic formula here for expanding your plant physically at no cost. What you *will* find are facts about a material that can definitely help expand your plant's productivity . . . and your product's salability.

That material is Masland Duran Clad, the new semi-rigid vinyl for laminating to metal sheets or coils according to your specifications . . . the built-in finish that obsoletes dipping, spraying, brushing, coating and similar finishing methods . . . the vinyl-to-metal laminate that can even do away with the need for having a finishing department.

Think what this can mean in terms of expanded productivity. Space now devoted to finishing operations can be used to expand your production area. Money currently spent in equipment, maintenance and finishing supplies can be channeled to more productive use. Costs of rejects, and the insurance costs of handling explosive materials can be eliminated, too, since Clad enables you to work with *prefinished* parts.

Consider, too, what Clad can mean in greater sales potential for your product. This durable, decorative vinyl can be produced in easy-to-clean colors . . . and in plain, textured or embossed designs. And here's the beauty of Clad from a production standpoint: It can be cut, crimped, drilled and even deep-drawn, without affecting color or design . . . without distorting the material itself . . . and without the need for any special processing equipment or methods.

Truly, Masland Duran Clad merits your most serious consideration right now . . . for, make no mistake about this: *vinyl-to-metal laminates are here to stay and grow.* With production soaring from one million square feet to 18 million in just three years . . . and from 115 to 150 million square feet estimated for 1960 . . . they are obviously lowering finishing costs and increasing design flexibility in a big way.

To safeguard and improve *your* competitive position, you will find it well worthwhile to mail this coupon for more information on Masland Duran Clad . . . and the laminators serving your area.

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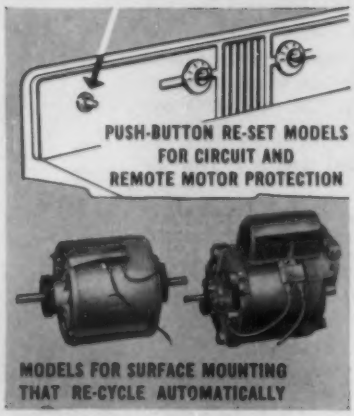

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DESIGN LITERATURE

Brainstorming

CHARLES H CLARK. Published by Doubleday & Co Inc, Garden City, NY. 5½ x 8, 262 pp. $4.50.

This first full-scale presentation on the subject of brainstorming, published about a year ago, will interest anyone concerned with creativity. In effect it is a series of lectures delivered by the author; therefore very easy to read and full of illustrative examples. End papers include the series of "Killer Phrases" that stop creativity, some of which appeared in an editorial in PRODUCT ENGINEERING, "Fifty Engineering Reasons Why," last July 20. It also includes a very interesting chapter on solo brainstorming, explaining how the individual or small group can follow the technique.

Because it is written in speech form, the text includes a great many examples of successful creativity. For example: A businessman-naturalist, fox hunting in Labrador, noticed that game frozen in mid-winter was more flavorful than game frozen in spring and fall. He studied the problem to find out why. His name was Clarence Birdseye. An Ohioan named Herbert Piker had inherited a metal-box company which was in bad shape. He stared at a minnow bucket and came up with the idea that insulation between the two cans would be helpful. The result was the Scotch Cooler.

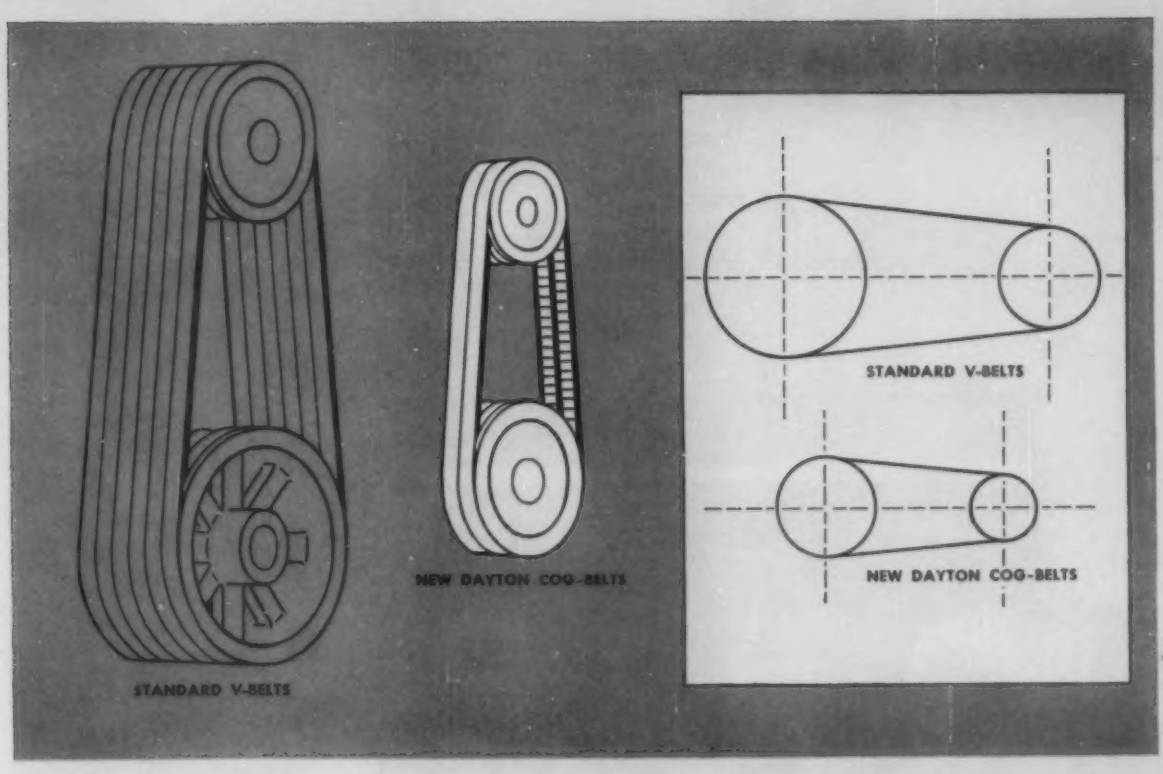
A third example deals with the assistant traffic manager of the Marconi Electrical Telegraph Company who, in 1915, submitted a memorandum which is one of the most astounding in business history. It began, "I have in mind a plan of development which would make radio a 'household utility' in the same sense as the piano or phonograph. The idea is to bring music into the house by wireless.

"While this has been tried in the past by wires, it has been a failure because wires do not lend themselves to this scheme. With radio, however, it would seem to be entirely feasible. For example—a radio telephone transmitter having a range of, say, 25 to 50 miles can be installed at a fixed point where instrumental or vocal music or both are produced. The problem of transmitting music has already been solved in principle, and therefore all the receivers attuned to the transmitting wave length should be capable of receiving such music. The receiver can be designed in the form of a simple 'Radio Music Box' and arranged for several different wave lengths, which should be changeable with the throwing of a single switch or pressing of a single button.

"The 'Radio Music Box' can be supplied with amplifying tubes and a loud-speaking telephone, all of which can be neatly mounted in one box. The box can be placed on a table in the parlor or living room, the switch set accordingly, and the transmitter music received. There should be no difficulty in receiving music perfectly when transmitted within a radius of 25 to 50 miles. Within such a radius there reside hundreds of thousands of families; and as all can simultaneously receive from a single transmitter, there would be no question of obtaining sufficiently loud signals to make the performance enjoyable . . ." The memo, which went on to explain the size of the transmitter necessary, the use of an antenna, transmitting of baseball scores, lectures, and so on, was tossed aside with a laugh. Five years later, when RCA was formed, the man who wrote the memo pulled it out of his files and sent it to Owen D. Young, chairman of the board of the new company. Four weeks later, he was asked for an estimate of future radio business. He showed that one million radios could be sold at approximately $75 each within three years, and that it would take about a year to ready the idea for production. In the three years 1922 to 1924, RCA sold $83,500,000 worth of Radio Music Boxes. The assistant traffic manager's name was David Sarnoff, now chairman of the board of RCA.

The book tells how to organize for brainstorming, how to do it, and how to assess the results. It also shows what happens if brainstorming is *not* done, in these words by J. A. Anderson of AC Spark Plug Division, GMC: "We have the cost of ideas not thought up. We have the cost of

(continued on page 92)



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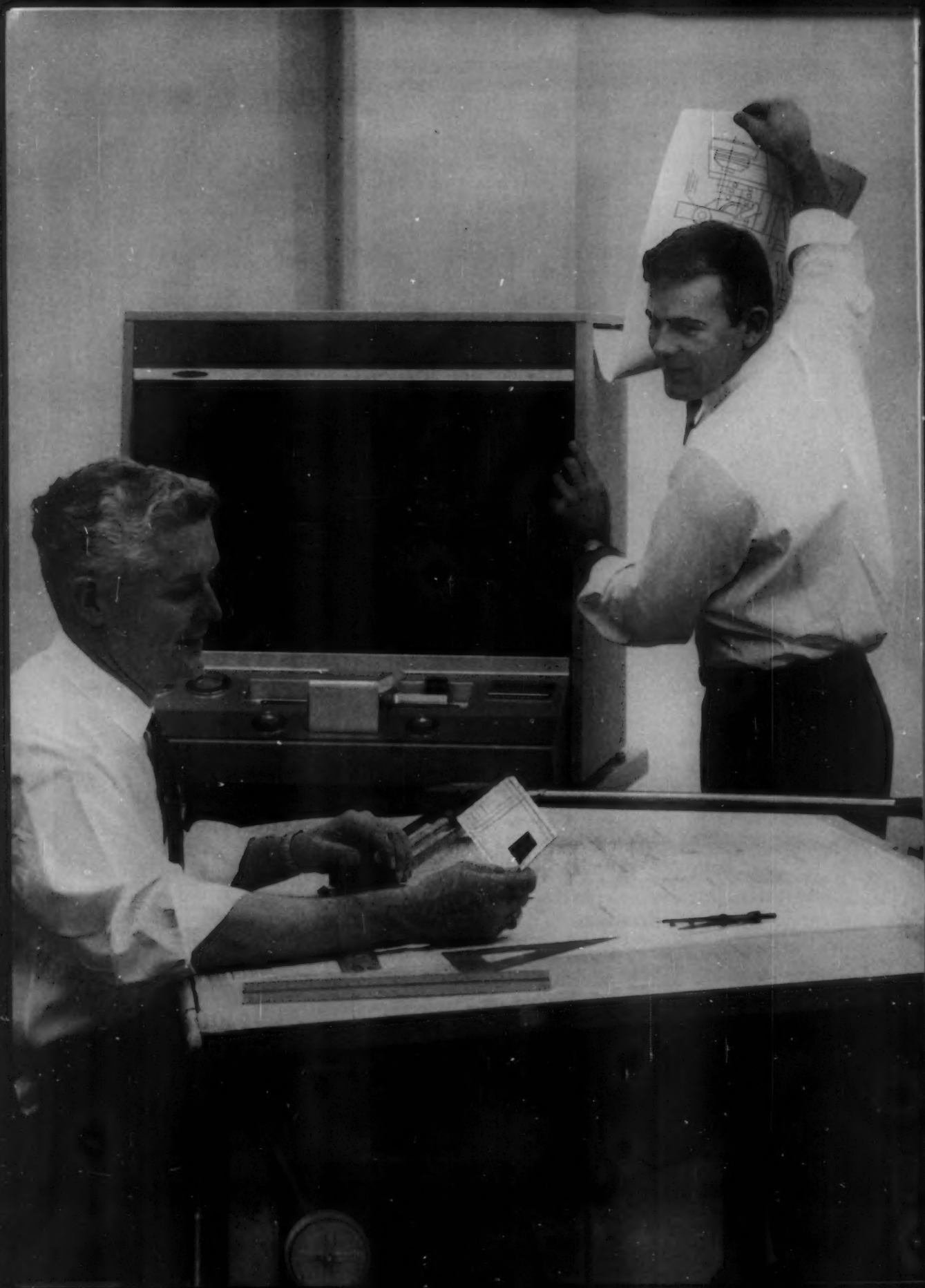

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ideas thought of too late. We have the cost of ideas not developed to their fullest potential. We have the cost of ideas not thought of at all." As the author says, "Ideas which people had—or not had—have made the difference in the whole history of man." —EJT

Design Forecast

A semiannual, hard-cover magazine, entitled "Design Forecast" and aimed at industrial designers and persons who hire them will use signed articles to impart information about aluminum products. Subscription costs $5 per year. Available from Aluminum Co of America, 1501 Alcoa Bldg, Pittsburgh 19.

Foundry Engineering

TAYLOR, FLEMINGS, WULFF. John Wiley & Sons Inc, 440 Fourth Ave, New York 16. 8 x 5½, 407 pp. $9.75.

Very good for its primary purpose, a textbook, it also makes a good refresher for those who have been away from the castings line. Its many illustrations are easy to visualize, and explain clearly the foundry techniques. Problems and experiments at the end of each chapter are well planned although difficult. The book has only a limited amount of design information.

Thermophysical Properties of Solid Materials

PB151715. ALEXANDER GOLDSMITH, THOMAS E WATERMAN, Armour Research Foundation. (WADC Technical Report 58-476). Office of Technical Services, Dept of Commerce, Washington 25, DC. 9½ x 11, about 300 pp. $6.

At the initiative of the Materials Laboratory, Wright Air Development Center, and under its sponsorship, a program was undertaken to evaluate and consolidate all original test data published since 1940 on the thermophysical properties of solid materials. While this task is in progress and yet incomplete, the need for early dissemination of information seemed to warrant the publication of this volume, which is based on a portion of the data assembled during the first year's effort. This volume is designed to be expandable so that it will lend itself to the inclusion of new data as well as to substitution or deletion.

Materials included in this survey are those which may find application in the design of missiles, aircraft, conventional or nuclear power plants, or allied equipment. Generally, only materials melting above 1000° F are included; exceptions are limited to the categories of plastics or composite materials.

Physical properties included in this survey are: density; melting point; latent heat of fusion; latent heat of vaporization; latent heat of sublimation; transformation temperature; specific heat; thermal conductivity; thermal diffusivity; emissivity; reflectivity; linear thermal expansion; vapor pressure; electric resistivity.

Internal Stresses and Fatigue In Metals

GERALD M RASSWEILER, WILLIAM L GRUBE. D. Van Nostrand Co Inc, 120 Alexander St, Princeton, NJ. 9½ x 7, 400 pp. $11.

In September 1958, a Symposium on Internal Stress and Fatigue in Metals was held by the General Motors Technical Center. Its purpose was to consider and interrelate the phenomena of internal stresses and fatigue in metals from both the atomistic approach of the solid state physicist and the phenomenological approach used so successfully by the engineer in the design of cyclically stressed components. The conference dealt with such questions as, what are the important factors that cause and influence internal stresses and fatigue in metals? Where is there a reciprocal influence? Where does the approach used by the engineer to study these phenomena merge with that employed by the metal physicist?

While internal stresses and fatigue were handled separately in some of the papers, the interrelation between the two became increasingly apparent as the conference proceeded. The basic nature of this relationship was revealed most clearly when the phenomena were analyzed in terms of the crystal lattice.

The papers presented at the symposium, as well as written discussions, are assembled in this book. The arrangement follows the symposium program, first introducing internal stresses and then considering lattice strains

(continued on page 97)

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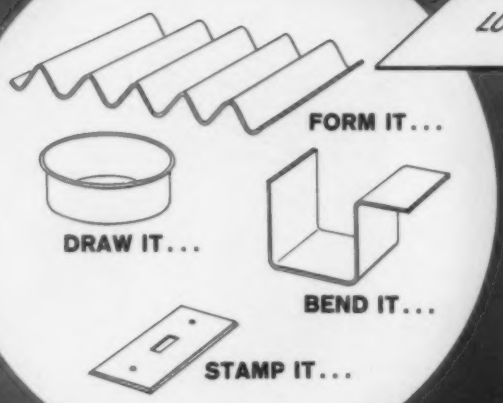

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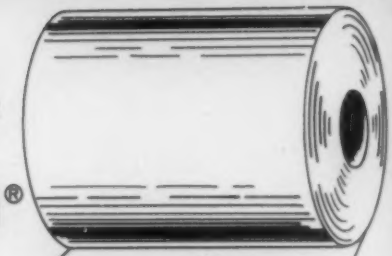

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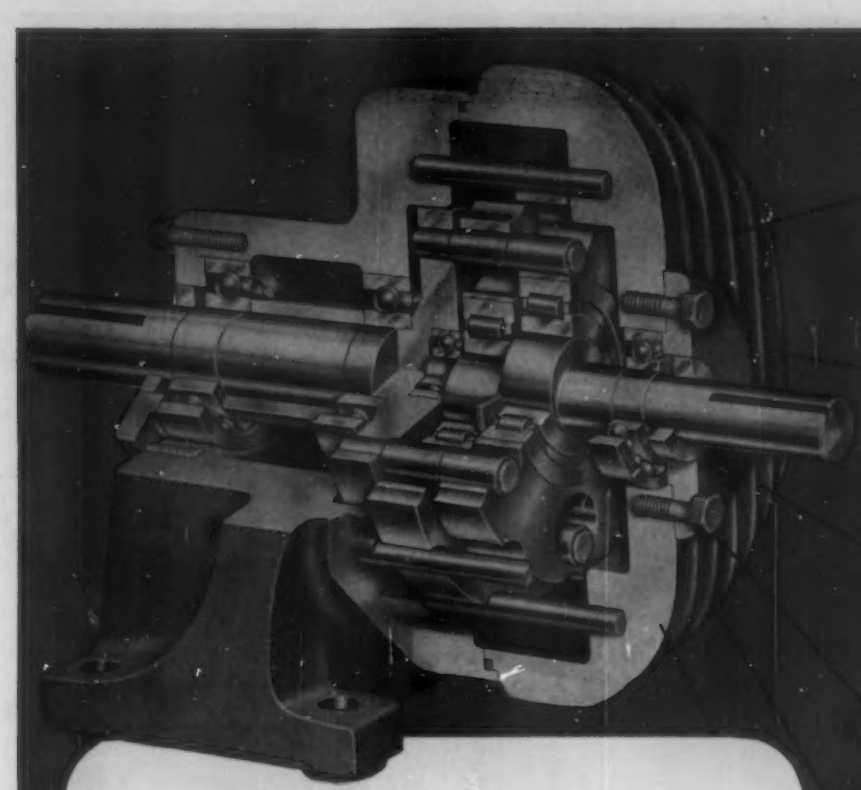

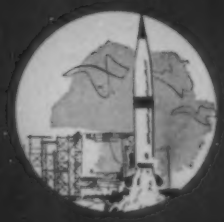

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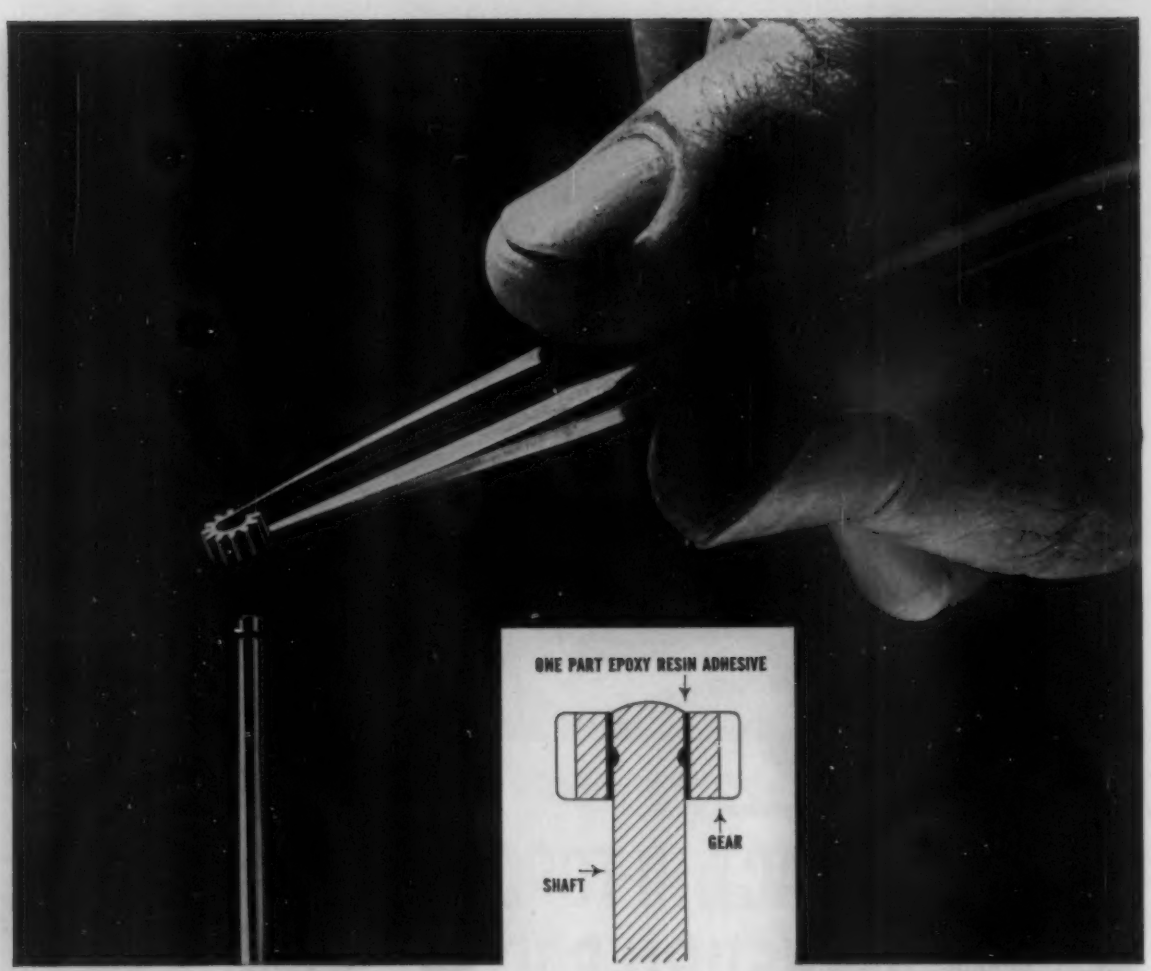

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and defects before studying fatigue and its relation to internal stress. In this manner the importance of crystal imperfections and stresses in the development of fatigue in metals is brought into focus.

ABSTRACTS FROM THE LITERATURE

Estimating Vibration and Shock

The methods presented are not to be used as a substitute for measuring vibration and shock, but rather when measurement is not possible. Steady-state excitation, random excitation, shock excitation, limitations imposed by equipment fragility are all discussed.

"Methods of Estimation in Vibration and Shock Problems," C. T. Molloy, Space Technology Laboratories Inc; SAE paper 100W; SAE, 485 Lexington Ave, New York 17.

Synthetic-lubricant Research

Presents briefly some of the elementary chemistry of synthetic oils and greases and brings the survey of synthetic lubricants up to date.

"Synthetic Lubricant Research"; Lubrication, Nov '59, 135 E 42nd St, New York 17.

Valve-sizing

Using a digital computer to size-control valves requires an evaluation of the equations usually supplied for such purposes. Given in this article are equations for liquid, gas, steam and Dowtherm, all of which can also be solved with a slide rule.

"Valve-sizing Equations for Computers," Orval P. Lovett, Jr, E I du Pont de Nemours & Co; ISA Journal, Nov '59, 313 Sixth Ave, Pittsburgh 22.

Rocket Motor-gear Analysis

Rocket motor turbine-pump reduction-gear system is analyzed with regard to Hertzian gear-tooth contact stresses and times of contact. It is found that the Hertzian contact stresses vary from approximately 100,000 to 200,000 psi. Contact times vary from 3 to 8 microsec. Some observations regarding correlation between contact times and gear failures are made. It may be possible to establish design limitations on contact times to insure satisfactory gear op-

(continued on page 98)

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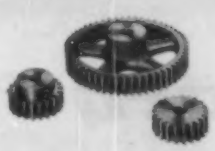

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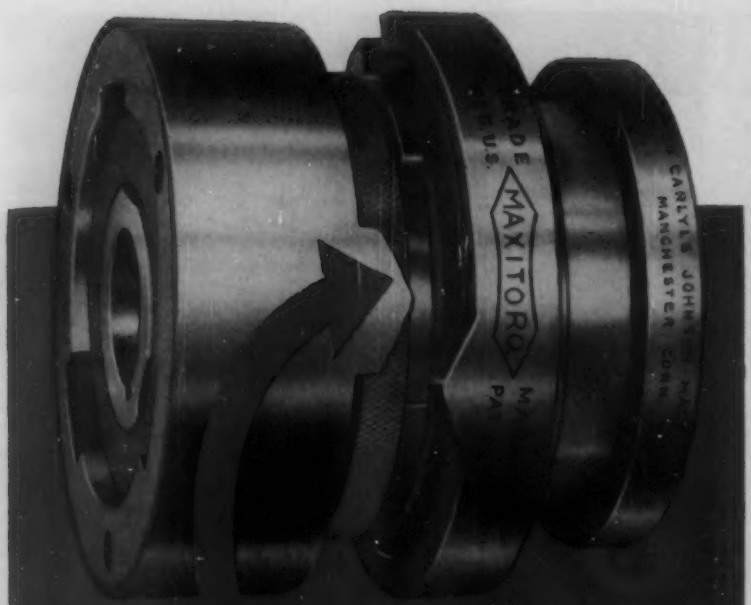

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eration. Sample calculations for evaluating each of typical quantities found in tables are included.

"Rocket Motor-Gear Tooth Analysis . . . Hertzian Contact Stresses and Times," Ernest K. Gatcombe and Roy W. Prowell; ASME Paper No. 59-A-256; ASME, 29 W 39th St, New York 18.

Alloy Selection

Under the heading, "Overcoming the Producibility Barrier," a series of articles discusses latest developments, significant applications, production techniques, and other factors involved in selecting copper-base, stainless, magnesium, wrought aluminum, carbon and other steel alloys.

"Overcoming the Producibility Barrier," Paret, Leontis, White, Kasser, Dunn et al; Metal Progress, Oct '59, Metals Park, Novelty, Ohio.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

MOTOR CONTROL—Catalog 5900, 72 pp. Condensed listings of general products. Includes selector charts for magnetic and manual starters, style numbers and list prices. Contains descriptive copy, design information, stocking and ordering data for manual starters, magnetic controls, drum controllers, pressure switches, pilot devices and other motor-control products and accessories. Furnas Electric Co, 1050 McKee St, Batavia, Ill.

Circle 340 on Reader Service Card

PRECISION INSTRUMENT COMPONENTS—1960 master catalog 21, 416 pp. Pocket-size catalog contains MIL specs, descriptions, dimensions and prices of over 12,000 stock items. PIC Design Corp, 477 Atlantic Ave, East Rockaway, NY.

Circle 341 on Reader Service Card

THERMAL INSULATIONS — Catalog IN-244A, 54 pp. Each of six sections is devoted to description, available forms or types, advantages and specifications of specialized group of thermal insulation. Johns-Manville Sales Corp, 22 E 40th St, New York 16.

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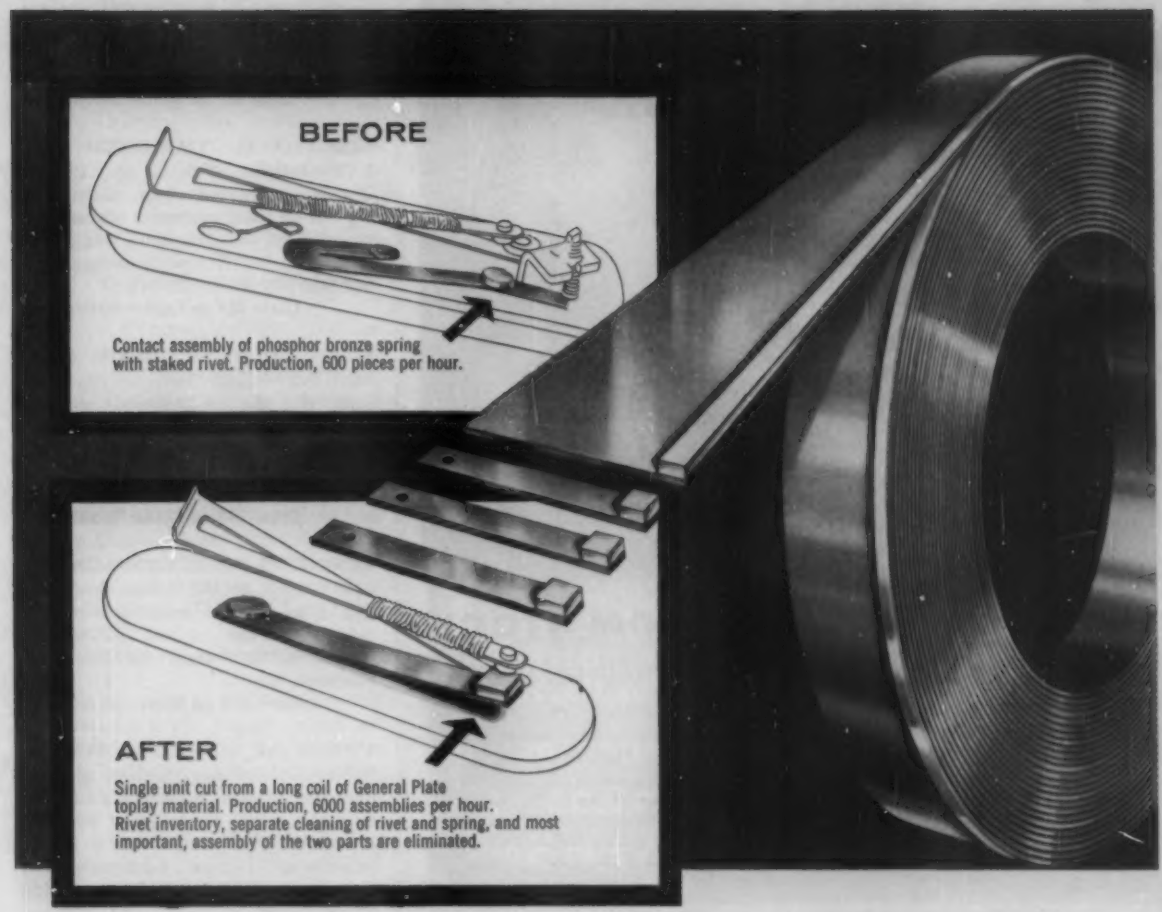
MOTOR REDUCERS—Catalog MR-58, 28 pp. Describes construction and mechanical features of motor reducers in eight housing sizes for use to 125 hp. Also gives load characteristics, mounting di-

(continued on page 100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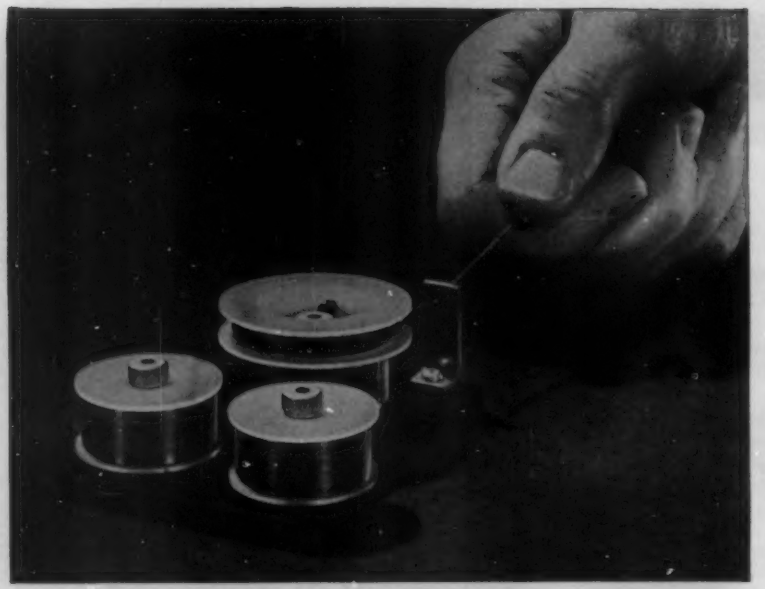

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A2025-1	.78	1.0	15	72	7,500	8.00
A2025-2	1.56	2.0	15	72	2,500	8.00
A2025-3	2.33	3.0	15	72	4,500	12.00
A2025-4	3.12	4.0	15	72	2,500	12.00
A2025-5	3.90	5.0	15	72	2,000	12.00

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mensions and parts lists. Philadelphia Gear Corp, 3620 G St, Philadelphia 34.
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ELECTRONIC TIME-DELAY RELAYS—Bulletin 5905, 8 pp. Includes description of circuit design, manufacturing and assembly processes, standard and special specs, sizes, mounting, weights and terminal styles. Tempo Instrument Inc, PO Box 338, Hicksville, NY.
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STOCK DIE-CAST GEARS AND PINIONS—Bulletin 3001, 10 pp. Presents zinc die-cast, one-piece gear-and-pinion combinations available from stock dies. With dimensional drawings and information. Gries Reproducer Corp, 400 Beechwood Ave, New Rochelle, NY.
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MINIATURE ELECTROMAGNETIC CLUTCHES, BRAKES—Data sheet AIM 959, 4 pp. Revised information on precision industrial control components. Autotronics Inc, Dept 22, Box 208, Florissant, Mo.
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TWO-STAGE, HIGH-HEAD PUMPS—Bulletin 1080, 4 pp. Describes specifications and design of hydraulically balanced two-stage pumps for leakproof pumping at heads to 600 ft, temperatures to 850 F, pressures to 3500 psi. Chempump Div, Fostoria Corp, PO Box 35-2, Huntingdon Valley, Penna.
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ROTARY SOLENOIDS—Data sheets, 2 pp each. Contains solenoid torque characteristics, direction of travel, voltage requirements, duty cycles, stroke in degrees, ambient temperatures, dimensional drawings and torque charts for 300 in.-lb-degree and 70 in.-lb-degree rotary solenoids. Pacsol Div, Illinois Tool Works, 3155 El Segundo Blvd, Hawthorne, Calif.
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IMPULSE TEST EQUIPMENT—Bulletin HY-1, 4 pp. Specifications, characteristics and performance information on Model R10900, with floor plan for test area. Resistoflex Corp, Roseland, NJ.
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ALL-PURPOSE RELAY—Bulletin 49, 1 p. Discusses features of economical relay employing nylon blade-lifter. Covers specifications. Artisan Electronics Corp, 171 Ridgedale Ave, Morristown, NJ.
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CHEMICAL MILLING—Booklet, 12 pp. Describes organization and function of company, as well as process of chemical

(continued on page 101)

milling. Chemical Contour Corp, 16627 S Avalon Blvd, Gardena, Calif.
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CENTRIFUGAL PUMP – Bulletin 420-D, 2 pp. Features and specifications of compact, leakproof pump for commercial and industrial applications. Dynapump Div, Fostoria Corp, PO Box 35-4, Huntingdon Valley, Penna.
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ALLOY TUBING STEELS – Folder TDC-193, 6 pp. Discusses through-hardening and case-hardening steels available in range of sizes; general characteristics of two grades and specifications. Babcock & Wilcox Co, Beaver Falls, Penna.
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HIGH-VACUUM PUMPS–Bulletin 8-20, 16 pp. Discusses Roots' Principle; application of vacuum equipment, performance of various pumping systems. Consolidated Vacuum Corp, 1775 Mt Read Blvd. Rochester 3.
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WELD DESIGN AND SYMBOLS–Bulletin 1100.1, 6 pp. Contains charts and illustrations that provide information on welding symbols and other basic welding design data. Lincoln Electric Co, Cleveland 17.
Circle 355 on Reader Service Card

ASSEMBLY FASTENERS–Brochure, 8 pp. Illustrates standard and custom-designed self-retaining assembly fasteners, together with typical applications. Robin Products Co, 27027 Groesbeck Highway, Warren, Mich.
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PLASTIC-CASED SWITCHES AND ACTUATORS–Catalog 12, 8 pp. Contains information on miniature and subminiature snap-action switches and auxiliary actuators. Also includes NEMA definitions for precision snap-acting switches. Haydon Switch Inc, Waterbury 20, Conn.
Circle 357 on Reader Service Card

ENGINES AND POWER UNITS–Folder CR-824-I, 8 pp. Covers 24 models, from stripped engines to complete power units. International Harvester Co, 180 N Michigan Ave, Chicago 1.
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ELECTRONIC HIGH-VACUUM PUMPS–Catalog sheet, 2 pp. Illustrates Model 150 together with corresponding power supply that operates units. Calibration curve is included with pump current plotted against pumping pressures. Ultek Corp, 920 Commercial St, Palo Alto, Calif.
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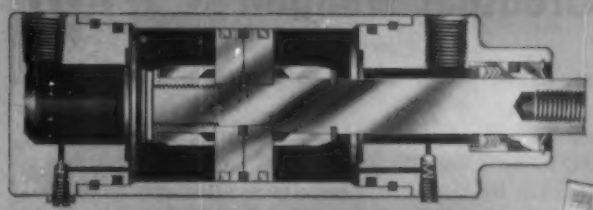

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How a grooved cam can assist in obtaining a wide variety of output motion. Jan 4 **Circle P 26**

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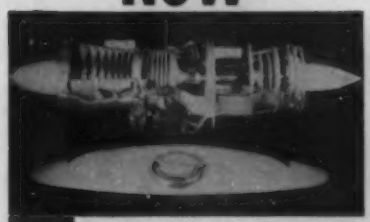

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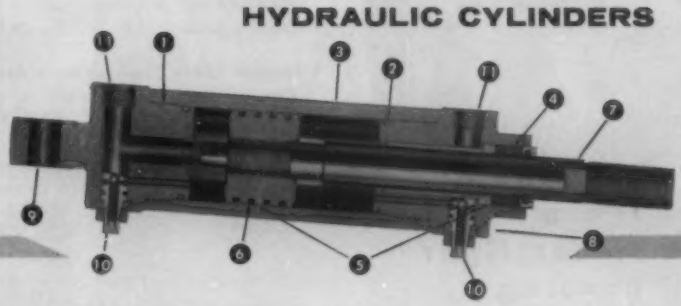

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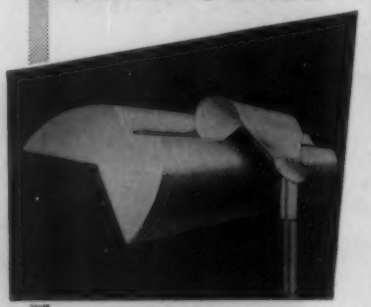

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Electric auto is example—how to choose the best motor for the load. Oct 12 Circle P 14

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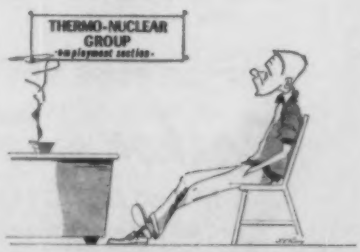

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Inexpensive, reliable and lightweight way to dissipate excess vibratory energy. R 29

Fiberglass-reinforced Plastic Molded Parts
7 key processes described. Explains their strong and weak points—and shows how one or the other becomes the logical choice in most commercial volume applications. R 28

THE NOR-building Block for Logic Circuits
Simple multiple-input electrical relay can be combined with other devices to perform logic functions. R 27

Design of External Shoe Brakes
New equations and coefficients provide a cook-book recipe. R 26

Cast Epoxies Give Time-saving Models (12/21/59)
A discussion on how these plastics will give shortcut prototypes. R 25

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Selection guide for core materials, facings and adhesives—presented in tabular form. Core materials include vegetable, mineral and plastic in solid, honeycomb and foam. Data on facings, cover metal, wood and plastic. Adhesives table lists properties for the 14 most widely used. R 18

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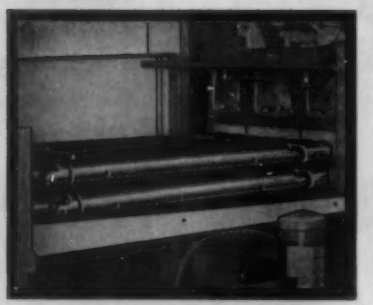

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INDEX OF PRODUCTS
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After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD

A

Actuators
  Mechanical 101
Adhesives 96
Aluminum Alloys 39
Aluminum Coated Sheet & Strip (see Steel, Coated) 39
Assemblies
  Hydraulic 14
Axles 110

B

Bars
  Metal 37
Bearing Materials 72
Bearings
  Sleeve 72
Belts, V 89
Bi-Metal 77
Brazing
  Alloys 38

C

Casters 32
Castings 30-31
Chains
  Conveyor 11
Chemical Treatments 82-83, 86
Chromium Alloys 46
Circuit Breakers 88
Clad Metals 99
Clutches
  Mechanical 98
Coatings 82-83, 86
Compressors 81
Contacts & Contact Materials 99
Controls
  Electrical 84, 88
  Hydraulic 14, 84, 101
  Pneumatic 84, 101
Conveyor Belts 78-79
Copper & Copper Alloys 6
Counters 29
Couplings
  Mechanical 20
Cylinders
  Hydraulic 103, 108

D

Discs, Clutch & Brake 98
Drafting
  Supplies 43
Drives
  Mechanical 95
  Variable Speed 26

E

Engine Indicators & Controls 102
Engineering Services (see also Production Services) .. 4th Cover, 78-79 102

F

Fastening Methods 80
Fibre 22-23
Finishing Equipment & Supplies 46
Flexible Shafts 40
Forgings 85

G

Gears 69, 97, 109

J

Joints
  Universal 106

M

Moldings
  Plastics (see Plastic Parts) 104
Motors, A-C
  Fractional ..... 4th Cover
  Integral ..... 4th Cover
Motors, Air 81
Motors, D-C
  Fractional ..... 4th Cover
  Integral ..... 4th Cover
Motors, Hydraulic 12

N

Nickel Alloys 46
Nuts 80

P

Photographic Equipment
  Film 90-91
Plastic Parts 80, 104
Plastics 87
Plastics Fabricated 22-23
Plastics Laminated 87
Production Services (see also Engineering Services) .. 4th Cover, 78-79, 103
Pumps
  Air 81
  Liquid ..... 2nd Cover
  Vacuum 81

R

Reproduction Supplies 43
Retaining Rings 19
Rust Proofing 82-83

S

Screws 10
Seals ..... 3rd Cover, 27, 80
Silver Alloys 38
Speed Reducers 95, 97
Springs 100
Steel
  Alloy ..... 2nd Cover
  Coated 2, 39

T

Thermostats 44
Transformers 107
Tubes 6

V

Valves
  Air 107

W

Wheels 32
Wire Cloth 21

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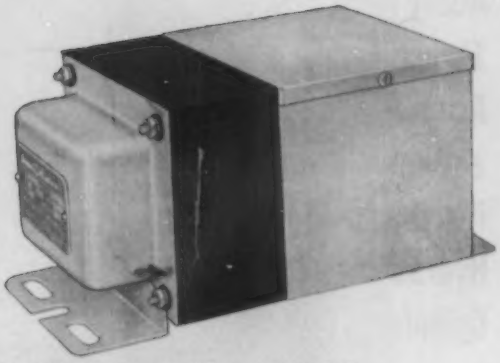

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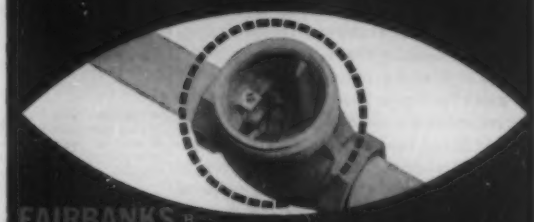

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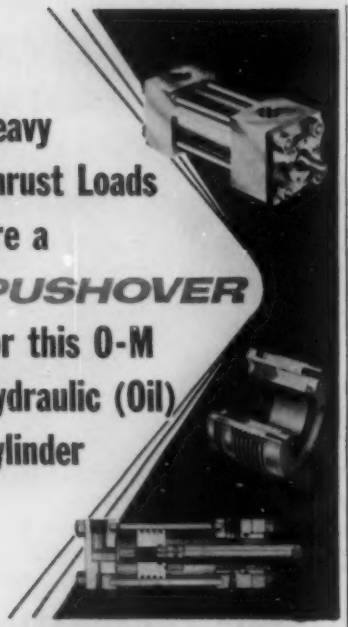

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INDEX TO ADVERTISERS

This index published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibilities for errors or omissions

A

Acme Electric Corp. 107
Albion Industries, Inc. 32
Allied Research Products, Inc. 86
Armco Steel Corp. 2
Atkins & Merrill, Inc. 103

B

Black Tool, Inc. 95

C

Carter Controls, Inc. 101
Chace Co., W. M. 77
Commercial Shearing & Stamping Co. 12
Curtis Universal Joint Co., Inc. 106

D

Dayton Industrial Products Co., Div., Dayton Rubber Co. 89
Dow Corning Corp. 41-42
du Pont de Nemours & Co., (Inc.), E. I., Polychemicals Dept. 75-76

E

Emerson Electric Mfg. Co. ..... 4th Cover
Equitable Engineering Co. 109

F

Fairbanks Co. 107
Federal-Mogul Div., Federal-Mogul-Bower Bearing, Inc. 72

G

Garlock Packing Co. 27
Gast Mfg. Corp. 81
General Electric Co., Apparatus Dept. 33-36
Gleason Works 69
Grip Nut Co. 80

H

Halogen Insulator & Seal Corp. 80
Hamilton Foundry, Inc. 85
Handy & Harman 38
Hunter Spring Co. 100

I

International Nickel Co., Inc. 46

J

Johnson Machine Co., Carlyle 98

K

Keuffel & Esser Co. 43

L

LaSalle Steel Co. 37
Link-Belt Co. 11

M

McGraw-Hill Book Co., Inc. 109
Malleable Casting Council 30-31
Masland Duraleather Co., The 87
Mechanical Products, Inc. 88
Metals & Controls, A Division of Texas Instruments Incorporated 44, 99
Minneapolis-Honeywell Regulator Co., Industrial Div. 84
Minnesota Mining & Mfg. Co., Adhesives, Coatings, Sealers Div. 96
Minnesota Mining & Mfg. Co. 90-91
Molded Fiber Glass Co. 104
Monarch Aluminum Mfg. Co. 39

N

National Seal Div., Federal-Mogul-Bower Bearing, Inc. ..... 3rd Cover
Newark Wire Cloth Co. 21

O

Ohio Gear Co. 97
Ortman-Miller Machine Co. 108

P

Parker-Kalon Div., General American Transportation Corp. 10
Parker Rust Proof Co. 82-83
Pathon Mfg. Co. 103

R

Reliance Electric & Engineering Co. 26
Revere Copper & Brass, Inc. 93-94
Rubber & Asbestos Corp. 105

T

Taylor Fibre Co. 22-23
Torrington Co., Bantam Div. 5

U

U. S. Axle Co., Inc. 110
U. S. Rubber Co., Mechanical Goods Div. 78-79

V

Veeder-Root, Inc. 29
Vernitron Corp. 102
Vickers, Inc., Div of Sperry-Rand Corp. 14

W

Waldes Kohinoor, Inc., Truarc Div. 19
Waldron-Hartig Div., Midland-Ross Corp. 20
White Dental Mfg. Co., S. S. Industrial Div. 40
Wolverine Tube Div. of Calumet & Hecla, Inc. 6
Worthington Corp. ..... 2nd Cover

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EMPLOYMENT OPPORTUNITIES . . . 107
Index to Advertisers appears on P. 108
Products Index appears on P. 106

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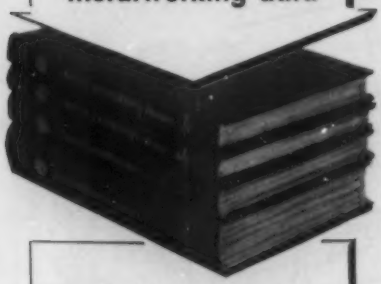

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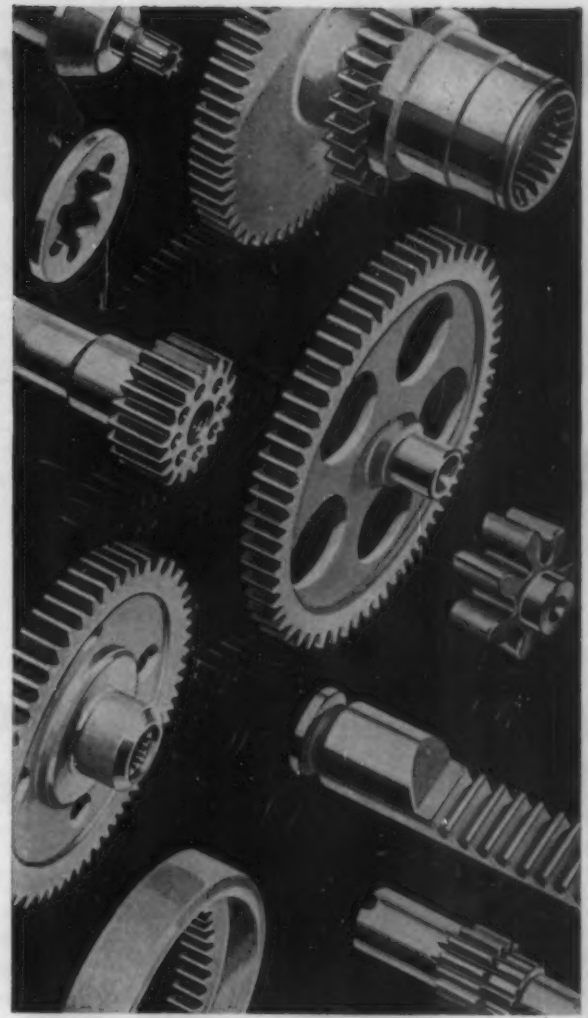

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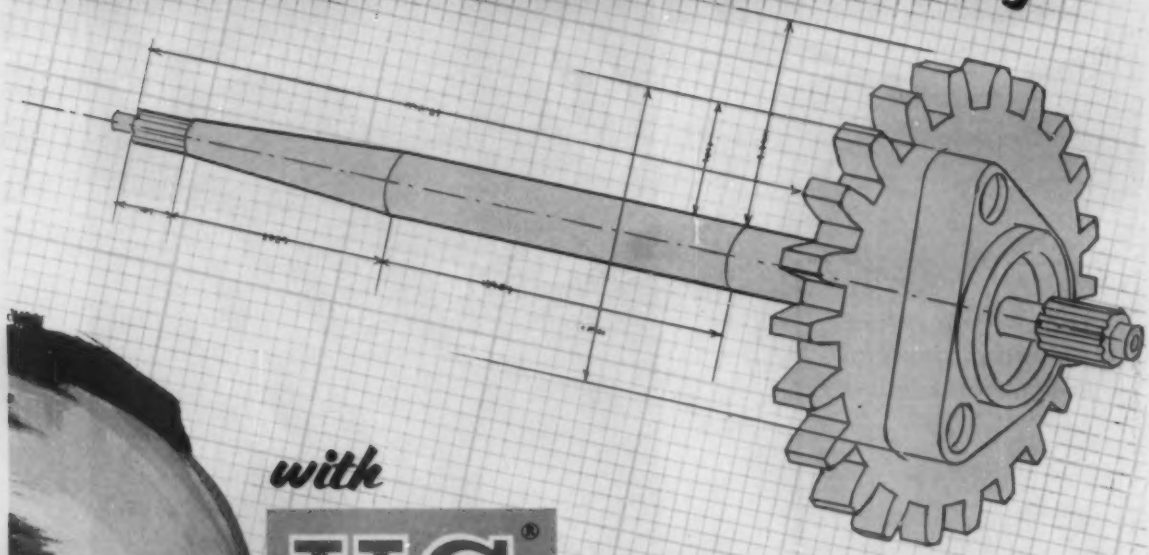

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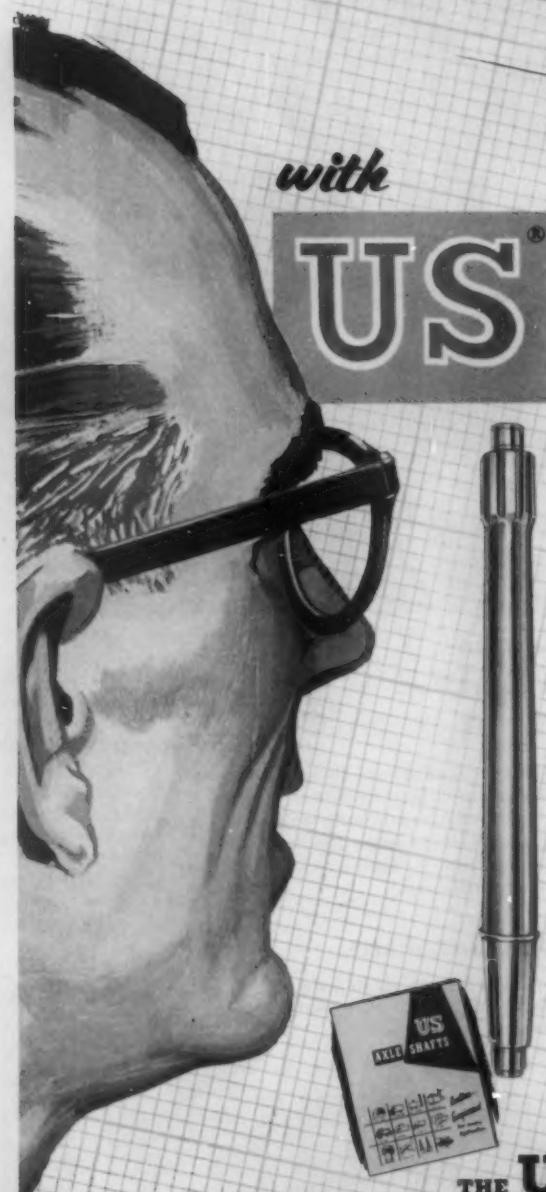

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P15—8 STEPS TO BETTER ENGINEERING WRITING—9/7—10/26

P16—YARDSTICKS FOR RESEARCH SUCCESS—10/19

P17—18 WAYS TO CONTROL GEAR BACKLASH—10/26

P18—PRESSURE LOSSES IN PNEUMATIC SYSTEMS—10/26

P19—LATEST TREND IN BOLT THREADS —11/9

P20—REINFORCED PLASTIC SPRINGS —11/9

P21—MECHANICAL RELIABILITY—11/16

P22—HIGH-TEMPERATURE REINFORCED PLASTICS—11/23

P23—ENGINEERING APTITUDE TESTS—11/30

P24—MULTI-VARIABLE EXPERIMENTS SIMPLIFIED—12/21

P25—RESERVE STRENGTH IN METAL PARTS—12/21

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1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	326	341	356	371	386
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	327	342	357	372	387
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	328	343	358	373	388
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	329	344	359	374	389
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS
P11 P12 P13 P14 P15 P16 P17 P18 P19 P20 P21
P22 P23 P24 P25 P26 P27 P28 P29 P30 P42

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NON-METALLIC MATERIALS, FINISHES

342—Thermal Insulations, 54 pp, Johns-Manville Sales Corp.

FABRICATION PROCESSES AND PRODUCTION

351—Chemical Milling, 12 pp, Chemical Contour Corp.

POWER TRANSMISSION

341—Precision Instrument Components, 416 pp, PIC Design Corp.

343—Motor Reducers, 28 pp, Philadelphia Gear Corp.

345—Stock Die-cast Gears and Pinions, 10 pp, Gries Reproducer Corp.

346—Miniature Electromagnetic Clutches, Brakes, 4 pp, Autotronics Inc.

FASTENING AND JOINING

355—Weld Design and Symbols, 6 pp, Lincoln Electric Co.

356—Assembly Fasteners, 8 pp, Robin Products Co.

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313—Medium-duty Pressed Steel Alloy

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HYDRAULIC, PNEUMATIC EQUIPMENT

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4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
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17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
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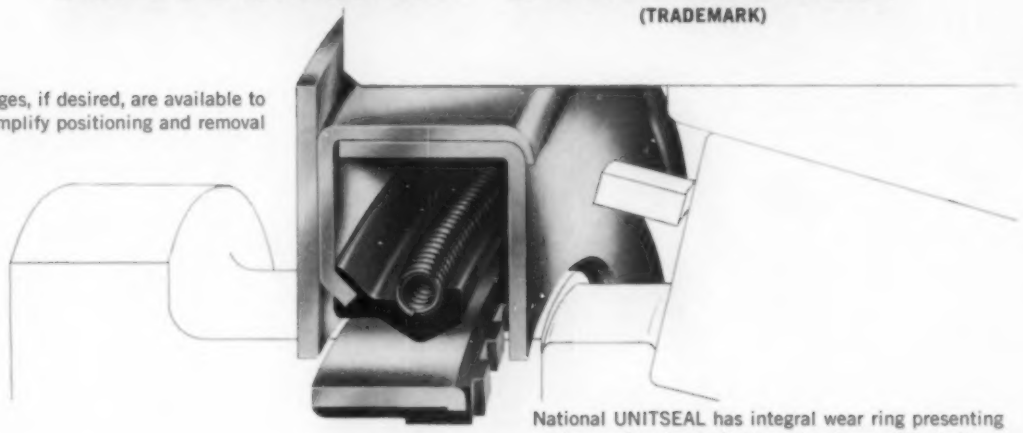

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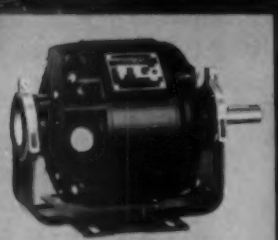

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